The simulation platform of
remote sensing mechanism models

User Manual

2015-12-10

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Part I Settings of the web client

1. System requirements

Item	Requirements
Runtime Environment	JRE (Java Runtime Environment) is required to run the platform.
Browser	**Microsoft IE 11** or later is preferred. The website to download JRE is: http://java.com

IMPORTANT!

Chrome no longer supports NPAPI (technology required for Java applets), so if you are using Chrome 4.5 or later, please access this model platform with Microsoft Internet Explorer (11 or later), or Safari. See specific information from Oracle.com:

"Chrome no longer supports NPAPI (technology required for Java applets)

The Java plug-in for web browsers relies on the cross platform plugin architecture NPAPI, which has been supported by all major web browsers for over a decade. Google's Chrome version 45 (scheduled for release in September 2015) drops support for NPAPI, impacting plugins for Silverlight, Java, Facebook Video and other similar NPAPI based plugins.

If you have problems accessing Java applications using Chrome, Oracle recommends using Internet Explorer (Windows) or Safari (Mac OS X) instead."

2. Settings for the web client

After installation of JRE, you can visit the address http://210.72.27.32:85 using Chrome. If the message box shown as Fig.1 popped out, you should set up your client environments as follows.

Java Application Blocked
Application Blocked by Java Security
For security, applications must now meet the requirements for the High or Very High security settings, or be part of the Exception Site List, to be allowed to run.
More Information
Reason: Your security settings have blocked a self-signed application from running
OK

Fig.1 The warning message

(1)Click "Java" in your Control Panel.

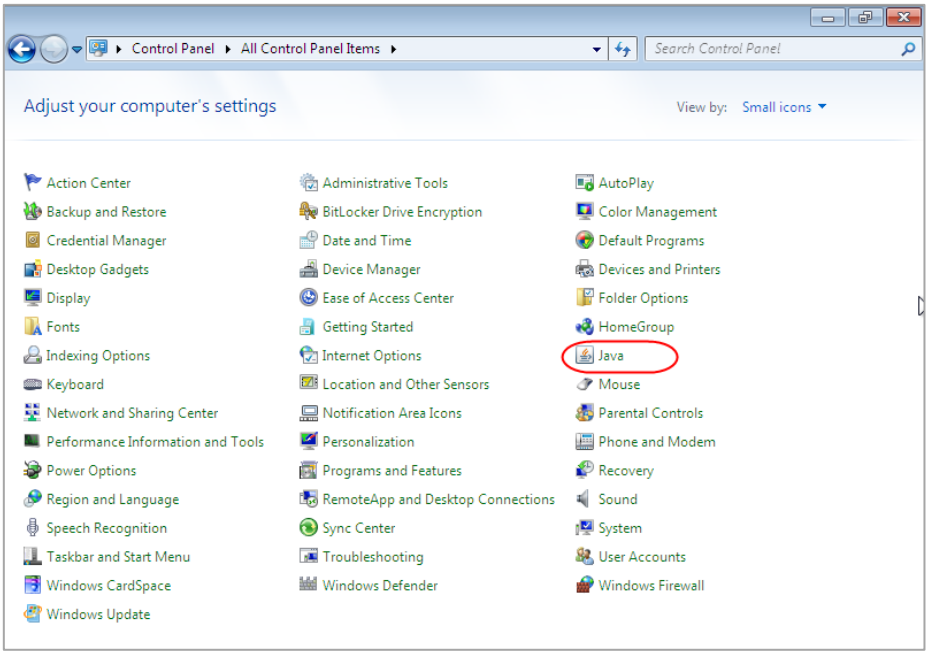


Fig.2 The Control panel

(2)Click the "Security" tab (Fig.3), and then the button "Edit Site List… ". Follow instructions shown in Figures 4 to 8 to configure your JRE environments.

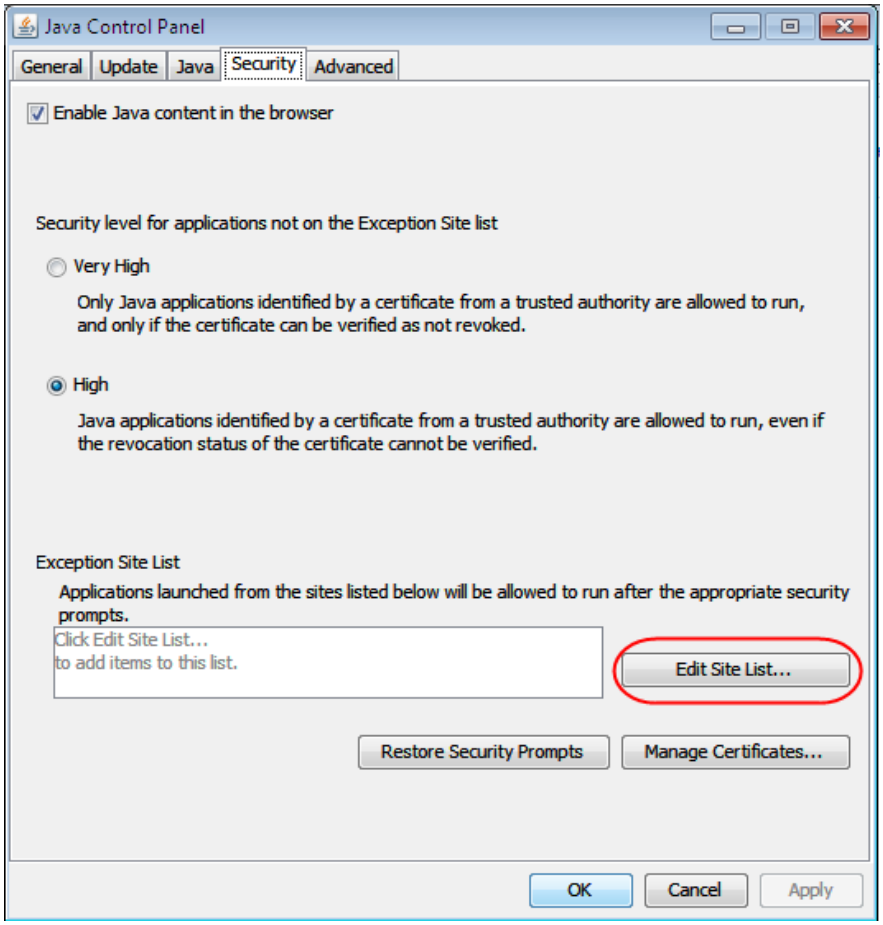

Java Control Panel
General
Update
Java
Security
Advanced
Enable Java content in the browser
Security level for applications not on the Exception Site list
Very High
Only Java applications identified by a certificate from a trusted authority are allowed to run, and only if the certificate can be verified as not revoked.
High
Java applications identified by a certificate from a trusted authority are allowed to run, even if the revocation status of the certificate cannot be verified.
Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Click Edit Site List...
to add items to this list.
Edit Site List...
Restore Security Prompts
Manage Certificates...
OK
Cancel
Apply

Fig.3 Click the button "Edit Site List…" in the Java Control Panel

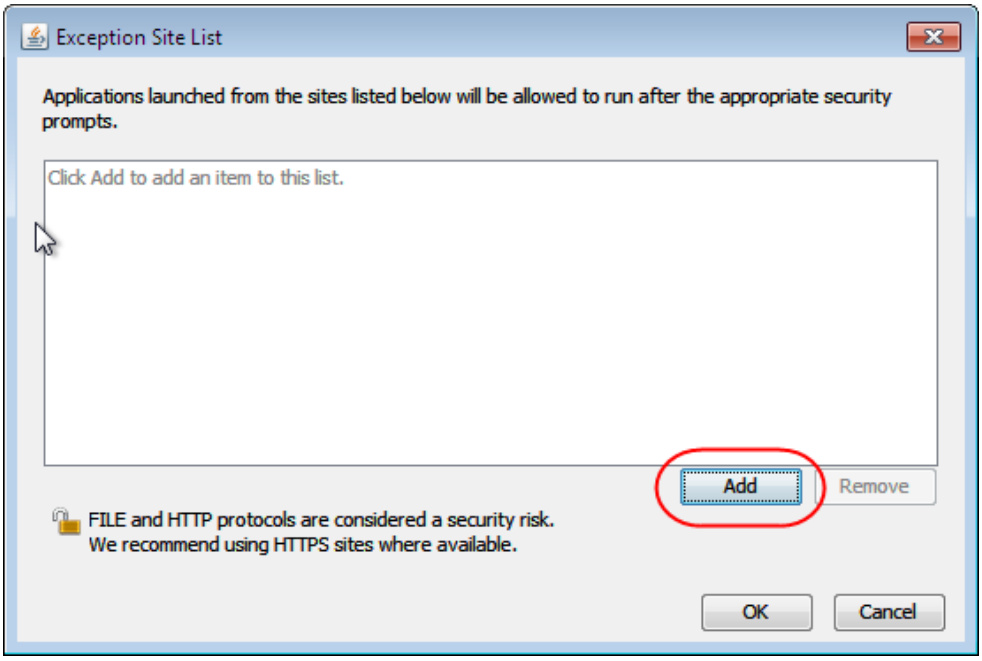

Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Click Add to add an item to this list.
Add
Remove
FILE and HTTP protocols are considered a security risk.
We recommend using HTTPS sites where available.
OK
Cancel

Fig.4 Click the button “Add” to add the address to the exception site list

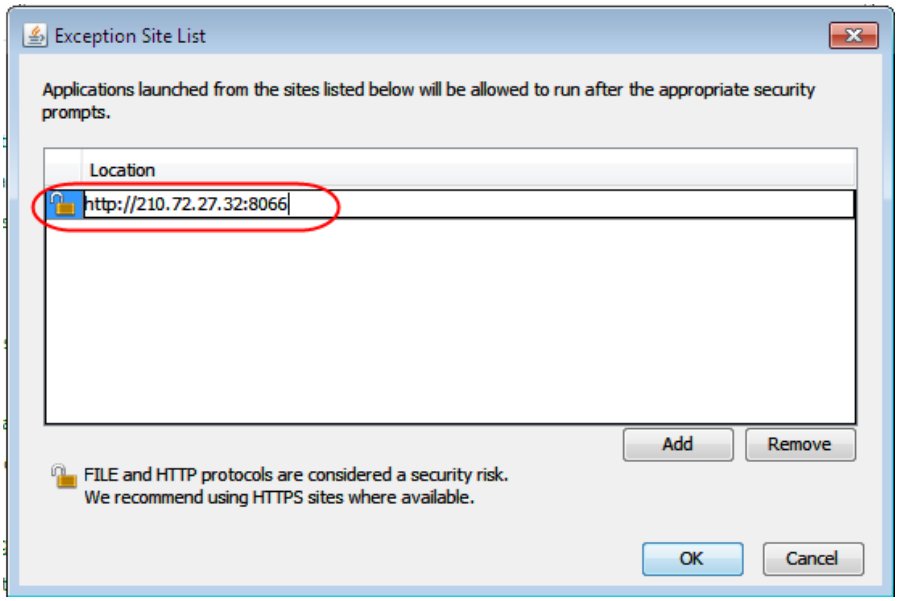

Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Location
http://210.72.27.32:8066
Add
Remove
FILE and HTTP protocols are considered a security risk.
We recommend using HTTPS sites where available.
OK
Cancel

Fig. 5 Input the URL http://210.72.27.32:8066 into the location list

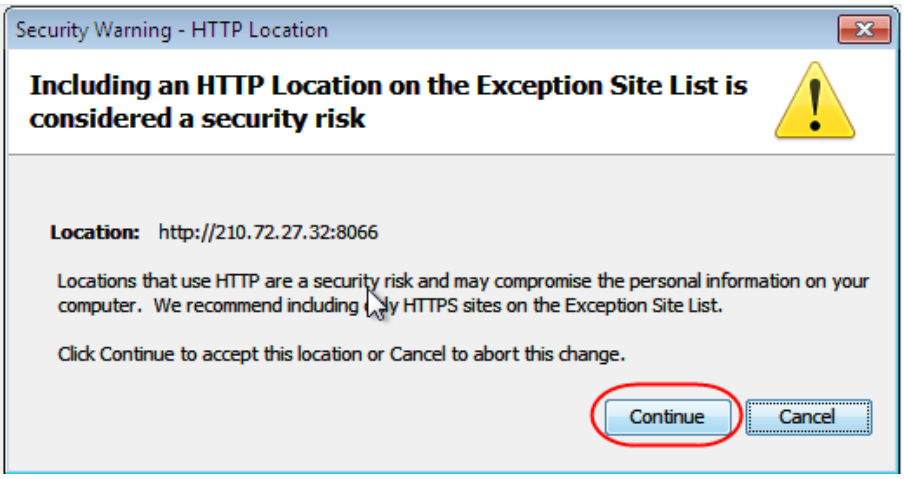

Security Warning - HTTP Location
Including an HTTP Location on the Exception Site List is considered a security risk
Location: http://210.72.27.32:8066
Locations that use HTTP are a security risk and may compromise the personal information on your computer. We recommend including only HTTPS sites on the Exception Site List.
Click Continue to accept this location or Cancel to abort this change.
Continue
Cancel

Fig.6 Click the button “Continue”

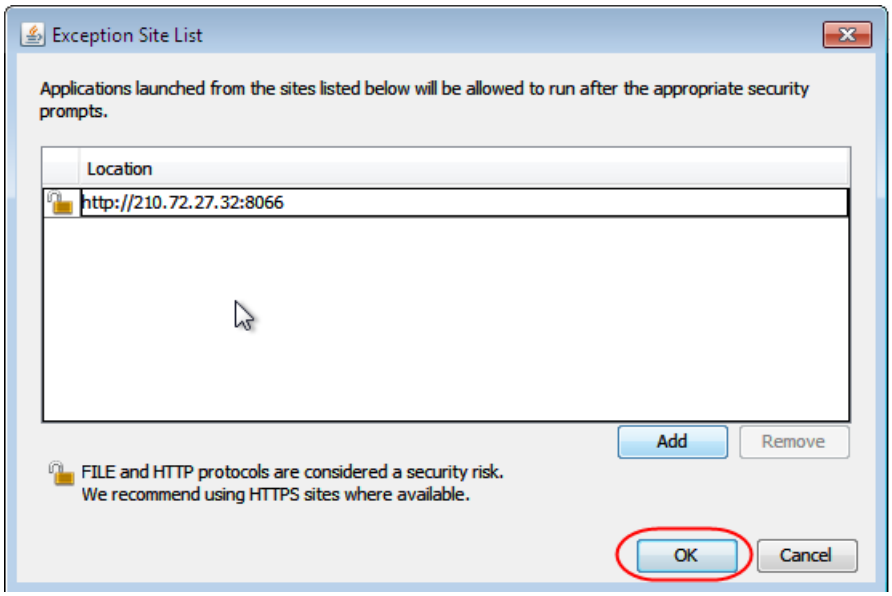

Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Location
http://210.72.27.32:8066
Add
Remove
FILE and HTTP protocols are considered a security risk.
We recommend using HTTPS sites where available.
OK
Cancel

Fig.7 Click the button “OK”

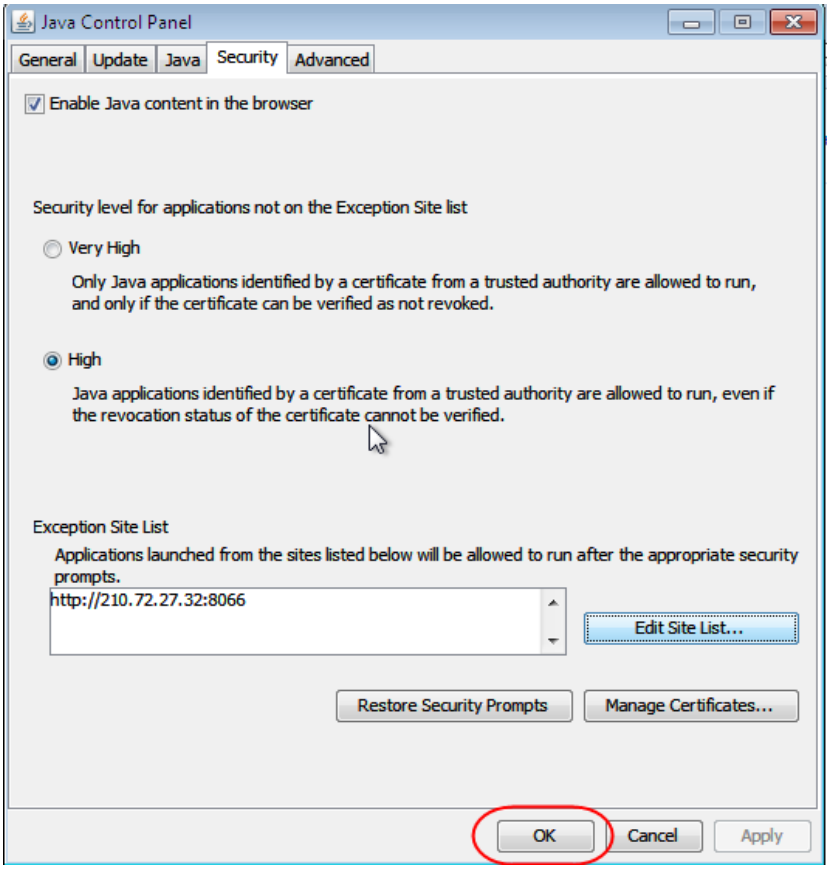

Java Control Panel
General
Update
Java
Security
Advanced
Enable Java content in the browser
Security level for applications not on the Exception Site list
Very High
Only Java applications identified by a certificate from a trusted authority are allowed to run, and only if the certificate can be verified as not revoked.
High
Java applications identified by a certificate from a trusted authority are allowed to run, even if the revocation status of the certificate cannot be verified.
Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
http://210.72.27.32:8066
Edit Site List...
Restore Security Prompts
Manage Certificates...
OK
Cancel
Apply

Fig.8 Click the button “OK”

(3)**CLOSE your web browser (NOTE here)**, and revisit the URL http://210.72.27.32:85. When the message-box of security warning pops up, click “I accept the risk and want to run this application” and then click the button “OK” (Fig.9). The settings for the client then ***achieved*** and all web services of the models in the platform can be accessed.

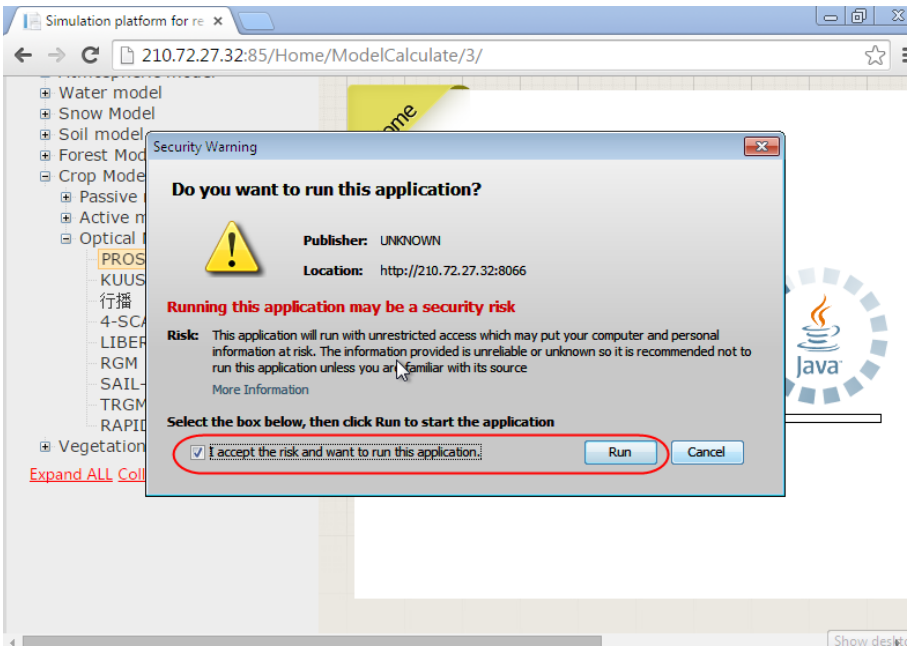


Fig.9 Response to the warning

3 Operations of the platform

3.1 The Welcome Page

When you visit http://210.72.27.32:85, the ***Welcome*** page will appear firstly (Fig.10). Click the image in the page, and you will be redirected to the ***Index*** page of the platform.

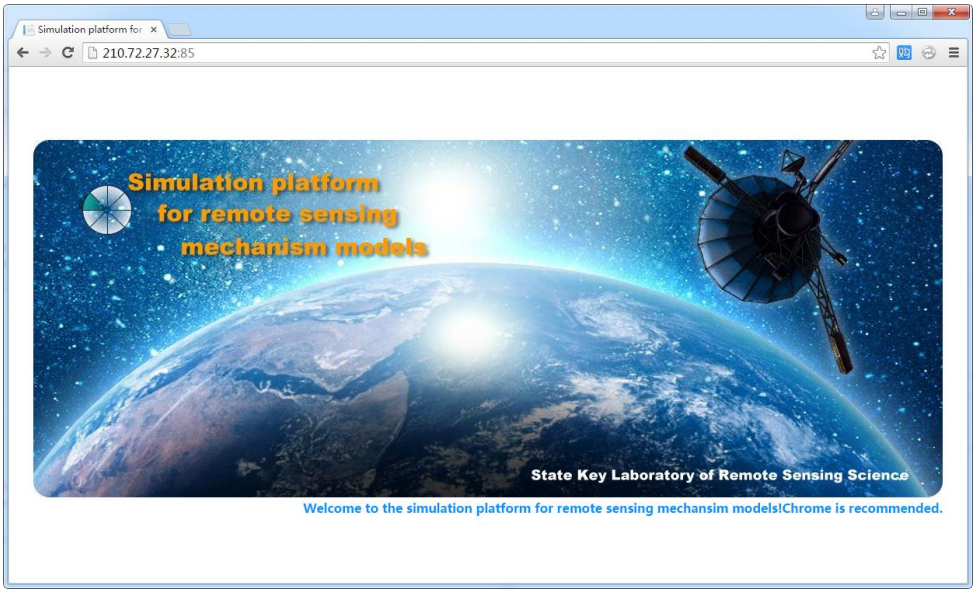

210.72.27.32:85
Simulation platform
for remote sensing
mechanism models
State Key Laboratory of Remote Sensing Science
Welcome to the simulation platform for remote sensing mechansim models!Chrome is recommended.

Fig.10 The Welcome page

3.2 The Index page

The remote sensing models are classified into 7 first classes which are list in the ***Index*** page (Fig.11). Each model of the first class is then sub-classed into second class models and third class models, which are listed in the page of ***ModelList*** (Fig.12).

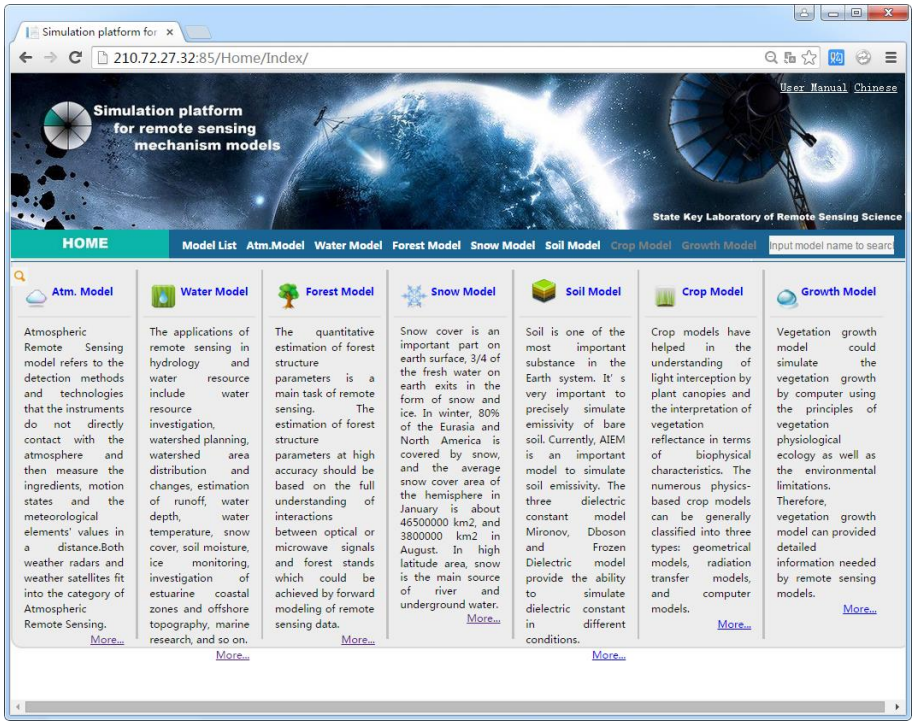

Simulation platform for
210.72.27.32:85/Home/Index/
User Manual Chinese
Simulation platform for remote sensing mechanism models
State Key Laboratory of Remote Sensing Science
HOME
Model List Atm.Model Water Model Forest Model Snow Model Soil Model Crop Model Growth Model
Input model name to searc
Atm. Model
Atmospheric Remote Sensing model refers to the detection methods and technologies that the instruments do not directly contact with the atmosphere and then measure the ingredients, motion states and the meteorological elements' values in a distance.Both weather radars and weather satellites fit into the category of Atmospheric Remote Sensing.
More...
Water Model
The applications of remote sensing in hydrology and water resource include water resource investigation, watershed planning, watershed area distribution and changes, estimation of runoff, water depth, water temperature, snow cover, soil moisture, ice monitoring, investigation of estuarine coastal zones and offshore topography, marine research, and so on.
More...
Forest Model
The quantitative estimation of forest structure parameters is a main task of remote sensing. The estimation of forest structure parameters at high accuracy should be based on the full understanding of interactions between optical or microwave signals and forest stands which could be achieved by forward modeling of remote sensing data.
More...
Snow Model
Snow cover is an important part on earth surface, 3/4 of the fresh water on earth exits in the form of snow and ice. In winter, 80% of the Eurasia and North America is covered by snow, and the average snow cover area of the hemisphere in January is about 46500000 km2, and 3800000 km2 in August. In high latitude area, snow is the main source of river and underground water.
More...
Soil Model
Soil is one of the most important substance in the Earth system. It' s very important to precisely simulate emissivity of bare soil. Currently, AIEM is an important model to simulate soil emissivity. The three dielectric constant model Mironov, Dboson and Frozen Dielectric model provide the ability to simulate dielectric constant in different conditions.
More...
Crop Model
Crop models have helped in the understanding of light interception by plant canopies and the interpretation of vegetation reflectance in terms of biophysical characteristics. The numerous physics-based crop models can be generally classified into three types: geometrical models, radiation transfer models, and computer models.
More...
Growth Model
Vegetation growth model could simulate the vegetation growth by computer using the principles of vegetation physiological ecology as well as the environmental limitations. Therefore, vegetation growth model can provided detailed information needed by remote sensing models.
More...

Fig.11 The Index page

3.3 Model List

In the page of ***ModelList*** (Fig.12), click the model name and the meta-data of the model will be displayed. The models which have been integrated into the platform are highlighted in **blue**.

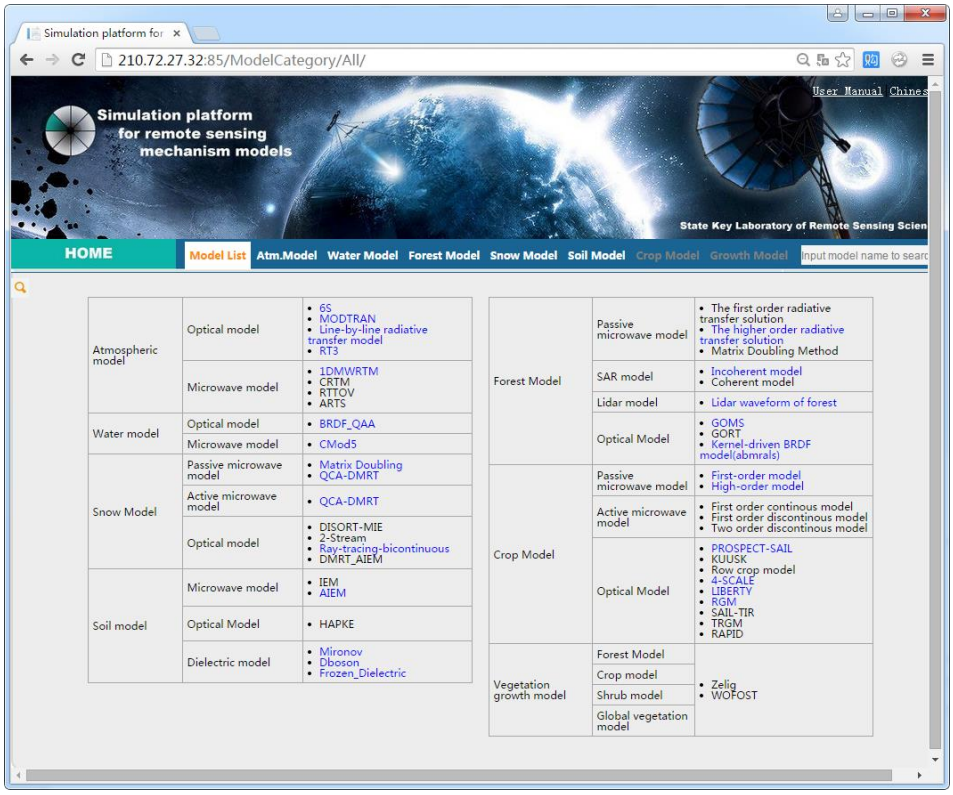


Fig.12 The Model List page

3.4 Meta-data of a model

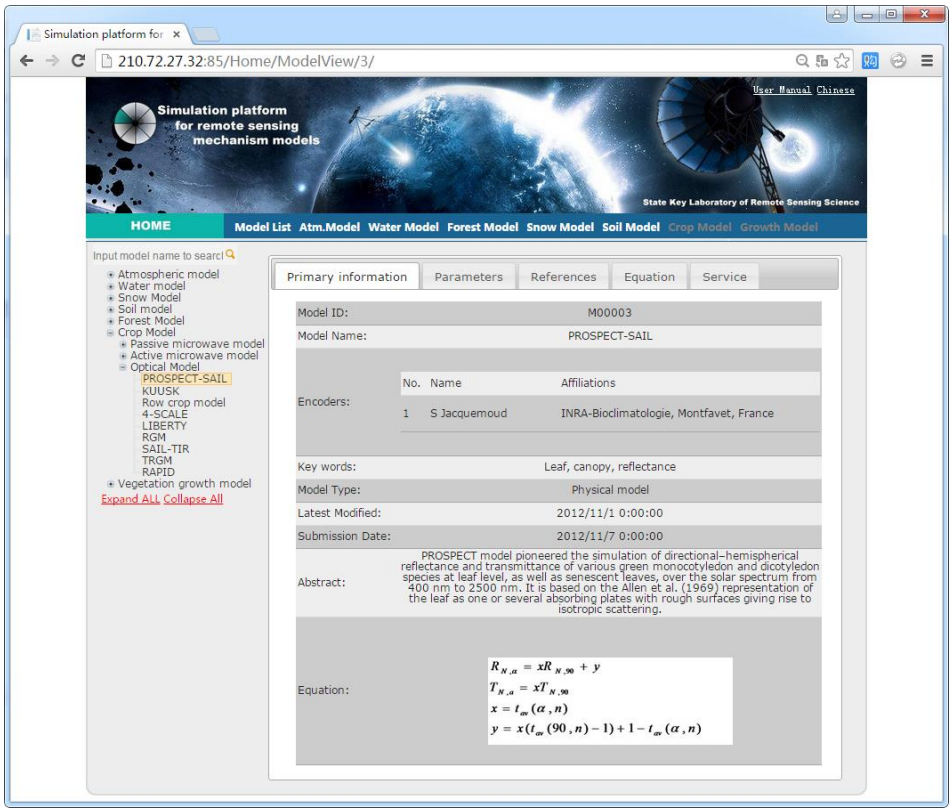

Simulation platform for
210.72.27.32:85/Home/ModelView/3/
Simulation platform for remote sensing mechanism models
User Manual Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List Atm.Model Water Model Forest Model Snow Model Soil Model Crop Model Growth Model
Input model name to searcl
Atmospheric model
Water model
Snow Model
Soil model
Forest Model
Crop Model
Passive microwave model
Active microwave model
Optical Model
PROSPECT-SAIL
KUUSK
Row crop model
4-SCALE
LIBERTY
RGM
SAIL-TIR
TRGM
RAPID
Vegetation growth model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00003
Model Name: PROSPECT-SAIL
Encoders:
No. Name Affiliations
1 S Jacquemoud INRA-Bioclimatologie, Montfavet, France
Key words: Leaf, canopy, reflectance
Model Type: Physical model
Latest Modified: 2012/11/1 0:00:00
Submission Date: 2012/11/7 0:00:00
Abstract:
PROSPECT model pioneered the simulation of directional–hemispherical reflectance and transmittance of various green monocotyledon and dicotyledon species at leaf level, as well as senescent leaves, over the solar spectrum from 400 nm to 2500 nm. It is based on the Allen et al. (1969) representation of the leaf as one or several absorbing plates with rough surfaces giving rise to isotropic scattering.
Equation:
$R_{N,\alpha} = xR_{N,90} + y$
$T_{N,\alpha} = xT_{N,90}$
$x = t_{ss}(\alpha, n)$
$y = x(t_{ss}(90, n) - 1) + 1 - t_{ss}(\alpha, n)$

Fig.13 The meta-data of a model

The meta-data are classified into the ***Primary information***, the ***Parameters***, the ***References***, the ***Equation***, and the ***Service*** (Fig.13). The URL to visit the web-service of the model can be found in the "***Service***" tab (Fig.14), and you can follow the instructions on the interface to run the model (Fig.15). The specific meta-data and the operations of all integrated models are described in the second part.

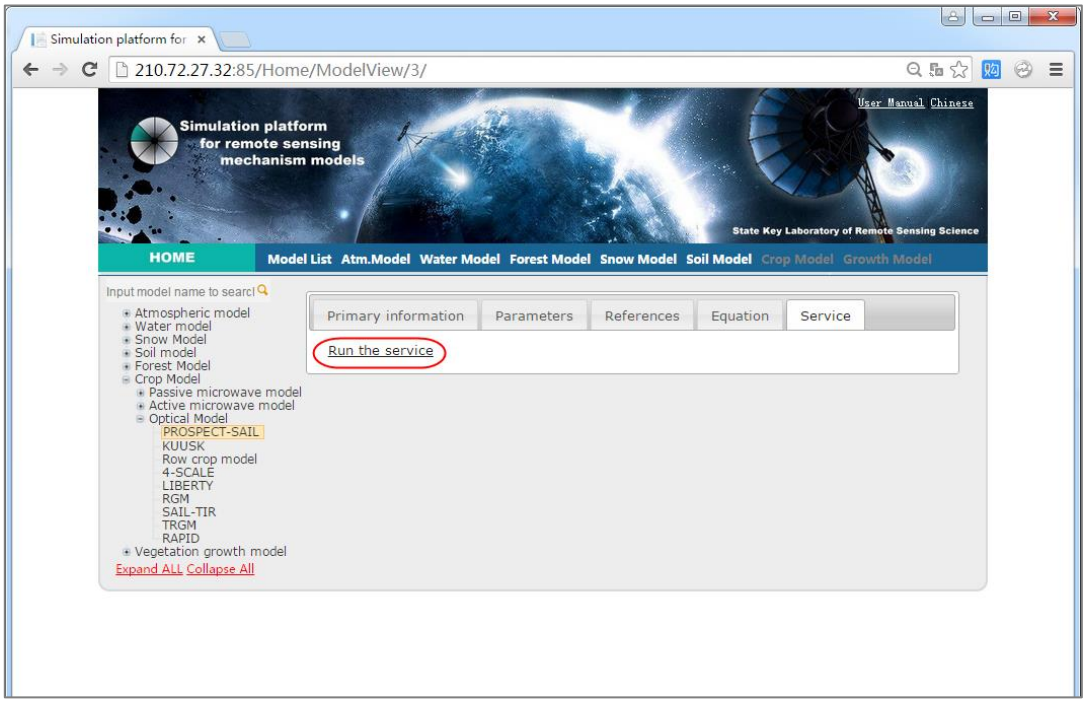


Fig.14 The service tab

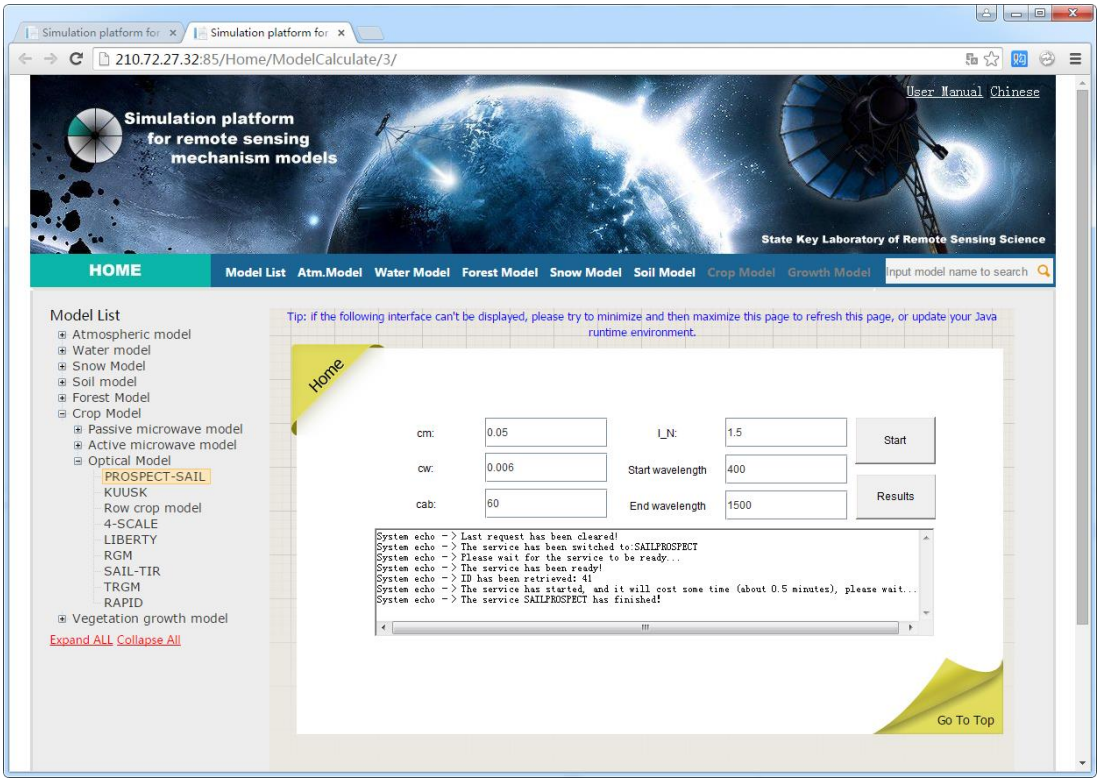


Fig.15 The interface of a model

4. Comments & feedbacks

The platform is technologically designed and developed by Dr. Wenhang Li. If you have any suggestion or comments, please contact with liwh@radi.ac.cn.

Part II User manuals of the online models

1.Atmosphere

1.1 Middle and low spectral resolution model

1.1.1 6S

(1)Brief Introduction

6S （Second Simulation of the Satellite Signal in the Solar Spectrum）atmosphere correction model was developed by Eric F. Vermote et al.（1997）in the basic of 5s model. 6S model can simulate the viriation of sunlight affected by atmosphere when it transmits in sun-surface-sensor. Compared to 5s model, altitude of target, non-Lambet surface and new absorption gas types (CH4, N2O, CO) are considered. It use the art approximation algorism and SOS algorism to improve the calculation precision of Rayleigh and aerosol reflection, and the spectral step is improve to 2.5nm. 6S model bases on radiation transmission theory, and it is used widely.

Reference：

Kotchenova, S. Y. and E. F. Vermote (2007). "Validation of a vector version of the 6S radiative transfer code for atmospheric correction of satellite data. Part II. Homogeneous Lambertian and anisotropic surfaces." Applied Optics 46(20): 4455-4464..

Vermote, E. F., et al. (1997). "Second Simulation of the Satellite Signal in the Solar Spectrum, 6S: An overview." Ieee Transactions on Geoscience and Remote Sensing 35(3): 675-686.

(2)Operation Instruction

1)Begin to Run

Choose the “atmospheric model->optical mode->6s” in “model list”. The main interface of the model is shown as Fig.1.

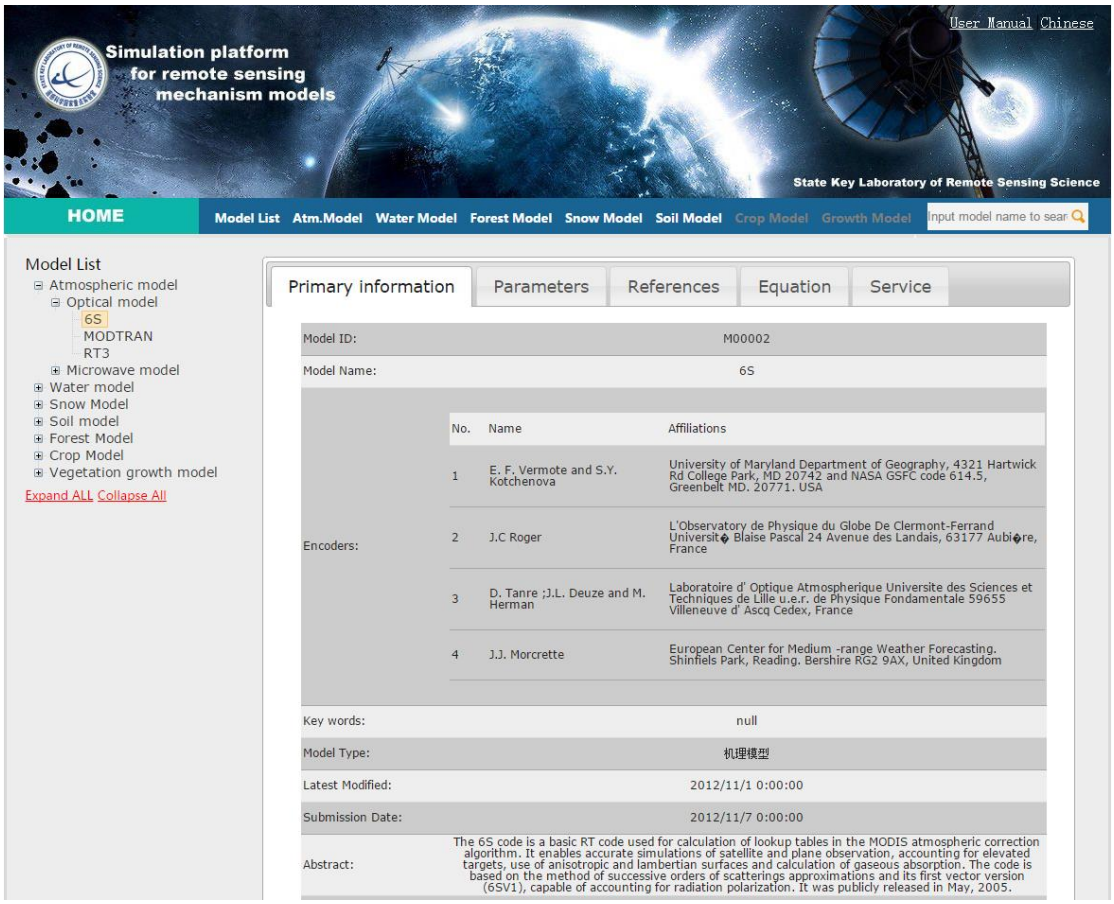

Simulation platform
for remote sensing
mechanism models
User Manual Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Input model name to sear
Model List
Atmospheric model
Optical model
6S
MODTRAN
RT3
Microwave model
Water model
Snow Model
Soil model
Forest Model
Crop Model
Vegetation growth model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00002
Model Name: 6S
Encoders:
No. Name Affiliations
1 E. F. Vermote and S.Y. Kotchenova University of Maryland Department of Geography, 4321 Hartwick Rd College Park, MD 20742 and NASA GSFC code 614.5, Greenbelt MD. 20771. USA
2 J.C Roger L'Observatory de Physique du Globe De Clermont-Ferrand Universit Blaise Pascal 24 Avenue des Landais, 63177 Aubi re, France
3 D. Tanre ;J.L. Deuze and M. Herman Laboratoire d' Optique Atmospherique Universite des Sciences et Techniques de Lille u.e.r. de Physique Fondamentale 59655 Villeneuve d' Ascq Cedex, France
4 J.J. Morcrette European Center for Medium -range Weather Forecasting. Shinfiels Park, Reading. Bershire RG2 9AX, United Kingdom
Key words: null
Model Type: 机理模型
Latest Modified: 2012/11/1 0:00:00
Submission Date: 2012/11/7 0:00:00
Abstract: The 6S code is a basic RT code used for calculation of lookup tables in the MODIS atmospheric correction algorithm. It enables accurate simulations of satellite and plane observation, accounting for elevated targets, use of anisotropic and lambertian surfaces and calculation of gaseous absorption. The code is based on the method of successive orders of scatterings approximations and its first vector version (6SV1), capable of accounting for radiation polarization. It was publicly released in May, 2005.

Figure 1 The main interface of 6S model

The model could be launched by left click on the card ―Service and then left click on the item ―Run the service‖. Click the button “start” to begin calculate. The running interface of Line-by-line radiative transfer model is shown as Fig.2. Next, the input parameter will be explained in order.

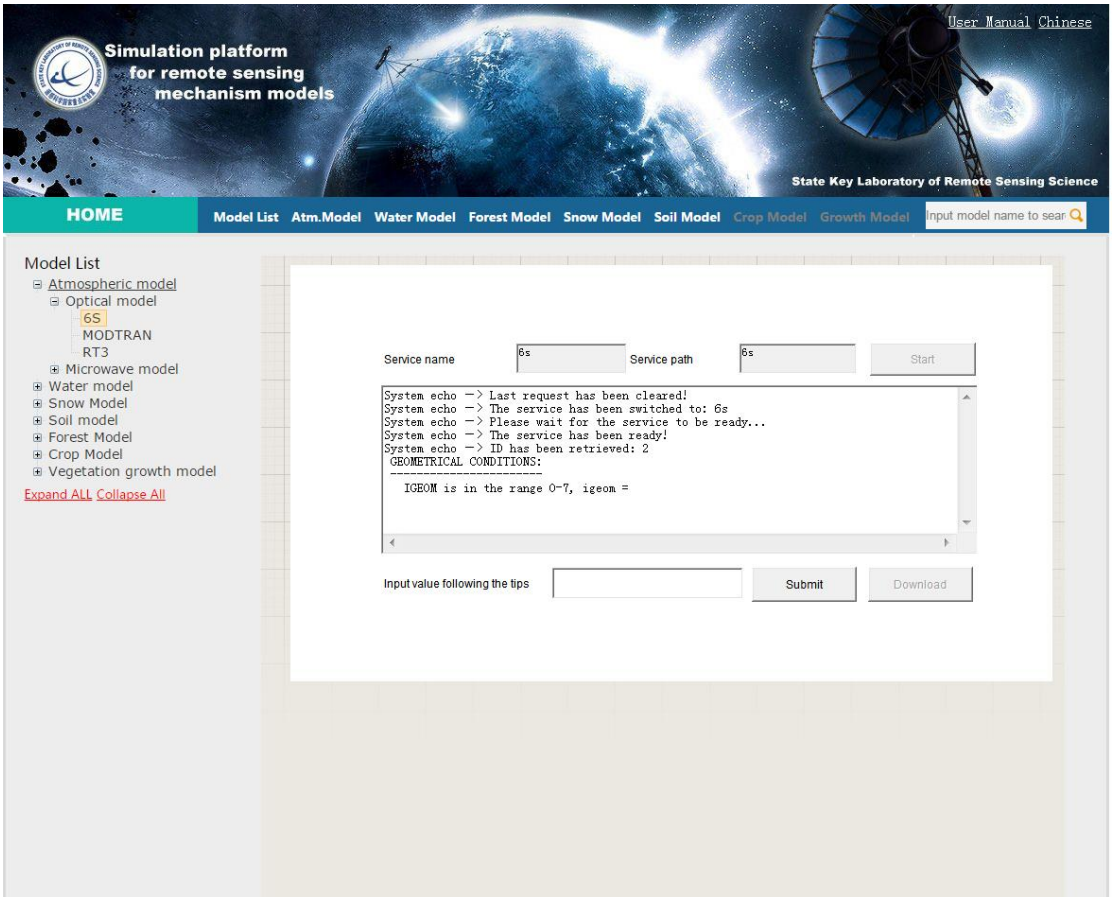


Figure 2 Running interface of 6S model

2)Parameter

①GEOMETRICAL CONDITIONS:

name：igeom

value range：0-7

igeom=0：user define the geometrical parameter

parameter：asol, phio, avis, phiv, month, jday

igeom=1-7 represent these satellite respectively

igeom=1：Meteosat

parameter：

month day hour

column row (pixel 5000*2500)

igeom=2：GOES (east)

parameter：

month day hour

column row (pixel 17000*12000)

igeom=3：GOES (west)

parameter：

month day hour

column row (pixel 17000*12000)

igeom=4：AVHRR (afternoon)
parameter：
month day hour
column (1-2048)
igeom=5：AVHRR(morning)
parameter：
month day hour
column (1-2048)
igeom=6：HRV(SPOT)
parameter：
month day hour longitude latitude
igeom=7：TM(LANDSAT)
parameter：
month day hour longitude latitude

②atmospheric model

name：idatm
value range：0-9

idatm =0：no gas
idatm =1：tropical atmosphere
idatm =2：middle latitude summer atmosphere
idatm =3：middle latitude winter atmosphere
idatm =4：subarctic summer
idatm =5：subarctic winter
idatm =6：US standard atmosphere
idatm =7：user-defined (34 layers)
include：altitude（km ） pressure(mb) temperature(k) vapour density(g/m^3) O3 density(g/m^3)
idatm =8：input total quantity of vapour and O3
水汽(g/cm^2) 臭氧 (cm-atm)
idatm =9：read radiosonde data

③aerosol type

name：iaer
value range：0-12

iaer=0: no aerosol
iaer=1: continental type
iaer=2: oceanic type
iaer=3: urban type
iaer=5: sand type
iaer=6: biomass burning type
iaer=7: stratosphere model
iaer=4: user-defined percentage of 4 aerosol type（0-1）

parameter input：
c(1) ： ash
c(2) ： water-soluble
c(3) ： ocean
c(4) ： smoke
iaer=8-10：user-defined aerosol model
iaer=8：multimodel normal distribution
iaer=9：improved gamma distribution
iaer=10：Junge power exponent distribution
iaer=11：define the aerosol model use the data of sun-photometer
iaer=12：use calculated result
print the file name

④aerosol concentration

parameter retrict: visibility > 5
name：v
value range：>5 or 0 or -1
v=bisibility（km）
v=0：input AOD550
v=-1：no aerosol

⑤altitude of target

name：xps
value range：

⑥sensor altitude

name：xpp
value range：

xpp= -1000：observe in satellite
xpp= 0：observe in situ
-100< xpp <0：observe in plane, absolute number represent the high of plane

⑦spectral conditions

name：iwave
value range：-2 – 70

iwave=-2 – +1， user-defined
iwave=2-70：choose a band

2 vis band of meteosat (0.350-1.110)
3 vis band of goes east (0.490-0.900)
4 vis band of goes west (0.490-0.900)
5 1st band of avhrr(noaa6) (0.550-0.750)
6 2nd " (0.690-1.120)
7 1st band of avhrr(noaa7) (0.500-0.800)
8 2nd " (0.640-1.170)
9 1st band of avhrr(noaa8) (0.540-1.010)

10 2nd " (0.680-1.120)
11 1st band of avhrr(noaa9) (0.530-0.810)
12 2nd " (0.680-1.170)
13 1st band of avhrr(noaa10 (0.530-0.780)
14 2nd " (0.600-1.190)
15 1st band of avhrr(noaa11 (0.540-0.820)
16 2nd " (0.600-1.120)
17 1st band of hrv1(spot1) (0.470-0.650)
18 2nd " (0.600-0.720)
19 3rd " (0.730-0.930)
20 pan " (0.470-0.790)
21 1st band of hrv2(spot1) (0.470-0.650)
22 2nd " (0.590-0.730)
23 3rd " (0.740-0.940)
24 pan " (0.470-0.790)
25 1st band of tm(landsat5) (0.430-0.560)
26 2nd " (0.500-0.650)
27 3rd " (0.580-0.740)
28 4th " (0.730-0.950)
29 5th " (1.5025-1.890)
30 7th " (1.950-2.410)
31 1st band of mss(landsat5)(0.475-0.640)
32 2nd " (0.580-0.750)
33 3rd " (0.655-0.855)
34 4th " (0.785-1.100)
35 1st band of MAS (ER2) (0.5025-0.5875)
36 2nd " (0.6075-0.7000)
37 3rd " (0.8300-0.9125)
38 4th " (0.9000-0.9975)
39 5th " (1.8200-1.9575)
40 6th " (2.0950-2.1925)
41 7th " (3.5800-3.8700)
42 MODIS band 1 (0.6100-0.6850)
43 MODIS band 2 (0.8200-0.9025)
44 MODIS band 3 (0.4500-0.4825)
45 MODIS band 4 (0.5400-0.5700)
46 MODIS band 5 (1.2150-1.2700)
47 MODIS band 6 (1.6000-1.6650)
48 MODIS band 7 (2.0575-2.1825)
49 1st band of avhrr(noaa12 (0.500-1.000)
50 2nd " (0.650-1.120)
51 1st band of avhrr(noaa14 (0.500-1.110)
52 2nd " (0.680-1.100)
53 POLDER band 1 (0.4125-0.4775)

54 POLDER band 2 (non polar(0.4100-0.5225)
55 POLDER band 3 (non polar(0.5325-0.5950)
56 POLDER band 4 P1 (0.6300-0.7025)
57 POLDER band 5 (non polar(0.7450-0.7800)
58 POLDER band 6 (non polar(0.7000-0.8300)
59 POLDER band 7 P1 (0.8100-0.9200)
60 POLDER band 8 (non polar(0.8650-0.9400)
61 FY-1C band 1 (0.5310-0.7490)
62 FY-1C band 2 (0.7610-0.9990)
66 FY-1C band 6 (1.4950-1.7330)
67 FY-1C band 7 (0.4000-0.5900)
68 FY-1C band 8 (0.4010-0.6190)
69 FY-1C band 9 (0.4330-0.6710)
70 FY-1C band 10 (0.8320-1.0700)

⑧ground reflectance type

name：inhomo

value range：0，1

inhomo=0：uniform surface

parameter：

idirec=0： no directional effect

input surface type igroun

igroun=-1:user define，input ro

igroun=0 ： user define，input ro array，step 0.0025um

igroun=1 ： VEGETA

igroun=2:CLEARW

igroun=3:SAND

igroun=4:LAKEW

idirec=1： directional effect

ibrdf=0： input reflectance in all direction

ibrdf=1-9： choose a defined type

ibrdf=1： hapke model

ibrdf=2： verstraete et al. model

ibrdf=3： Roujean et al. model

ibrdf=4： walthall et al. model

ibrdf=5： minnaert model

ibrdf=6： Ocean

ibrdf=7： Iaquinta and Pinty model

ibrdf=8： Rahman et al. model

ibrdf=9： Kuusk's multispectral CR model

⑨atmosphere correction mode

name：rapp

value range：

rapp<-1: do not activate the mode
rapp> 0：inversion surface reflectance to fit the TOA radiance=rapp（w/m^2/str/mic）
-1.<rapp<0：inversion surface reflectance to fit the TOA reflectance= -rapp

1.1.2 MODTRAN

(1) Brief Introduction

MODTRAN is a rapid atmospheric forward model with moderate spectral resolution. MODTRAN can calculate transmittance fast with good precise, using band model method in 0.2~100 micron spectral region which covers UV-VIS-TIR.

MODTRAN 4 adds the following features:

1) Two Correlated-k (CK) options: the standard option which use 17 k values per spectral bin and a slower, 33 k value option primarily for upper-altitude (>40km) cooling rate and weighting function calculations.
2) An option to include azimuth dependencies in the calculation of DISORT scattering contributions.
3) Upgraded ground surface modeling including parameterized forms for BRDFs and an option to define a ground image pixel different from its surrounding surface.
4) A high-speed option, most appropriate in short-wave and UV spectral regions, that uses 15 cm^{-1} band model.
5) Scaling options for water vapor and ozone column amounts.
6) Improved, higher spectral resolution, cloud parameter database; and more accurate Rayleigh scattering and indices of refraction.

References

Berk A, Bernstein L S, Robertson D C. MODTRAN: A moderate resolution model for LOWTRAN. SPECTRAL SCIENCES INC BURLINGTON MA, 1987.

Berk, A.; Bernstein, L. S.; Anderson, G. P.; Acharya, P. K.; Robertson, D. C.; Chetwynd, J. H.; Adler-Golden, S. M. (1998). "MODTRAN cloud and multiple scattering upgrades with application to AVIRIS". Remote Sensing of Environment(Elsevier) 65 (3,):367–375. doi:10.1016/S0034-4257(98)00045-5.

(2) Operation Instruction

The main interface of the model is shown as Fig.1.1.2-a. The model could be launched by left click on the card “Service” and then left click on the item “Run the service”. The running interface of Line-by-line radiative transfer model is shown as Fig.1.1.2-b.

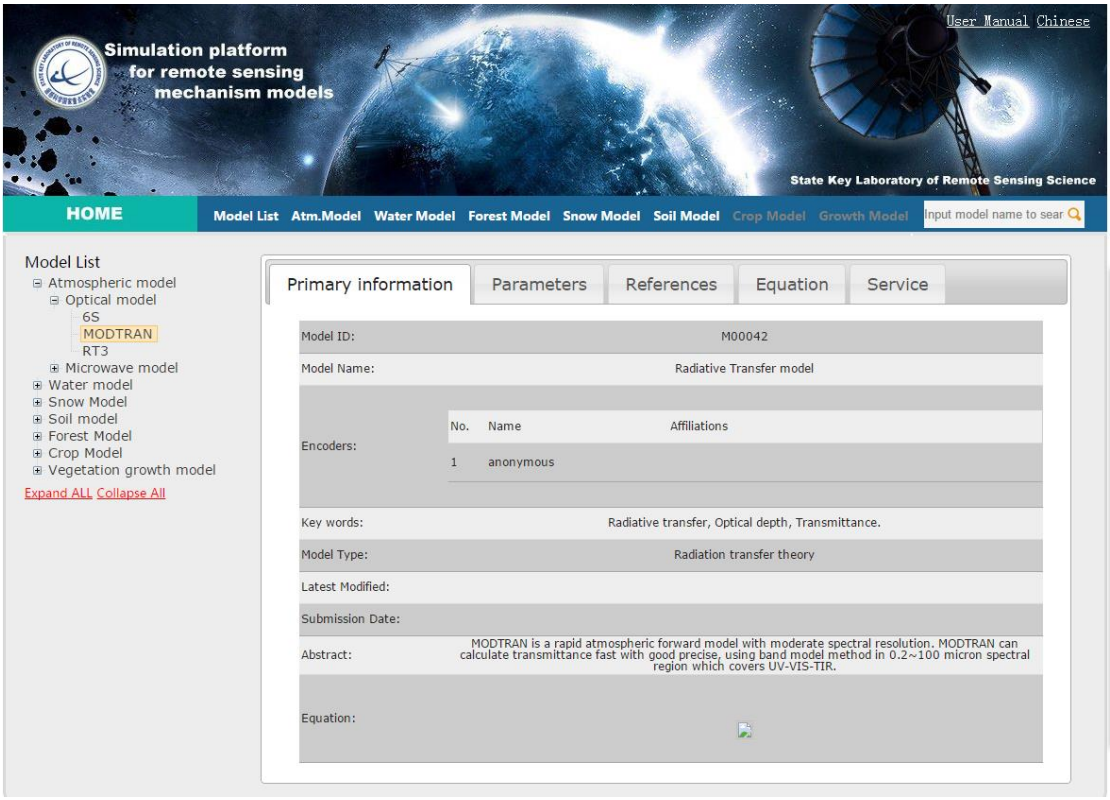


Fig 1.1.2-a Main interface of MODTRAN

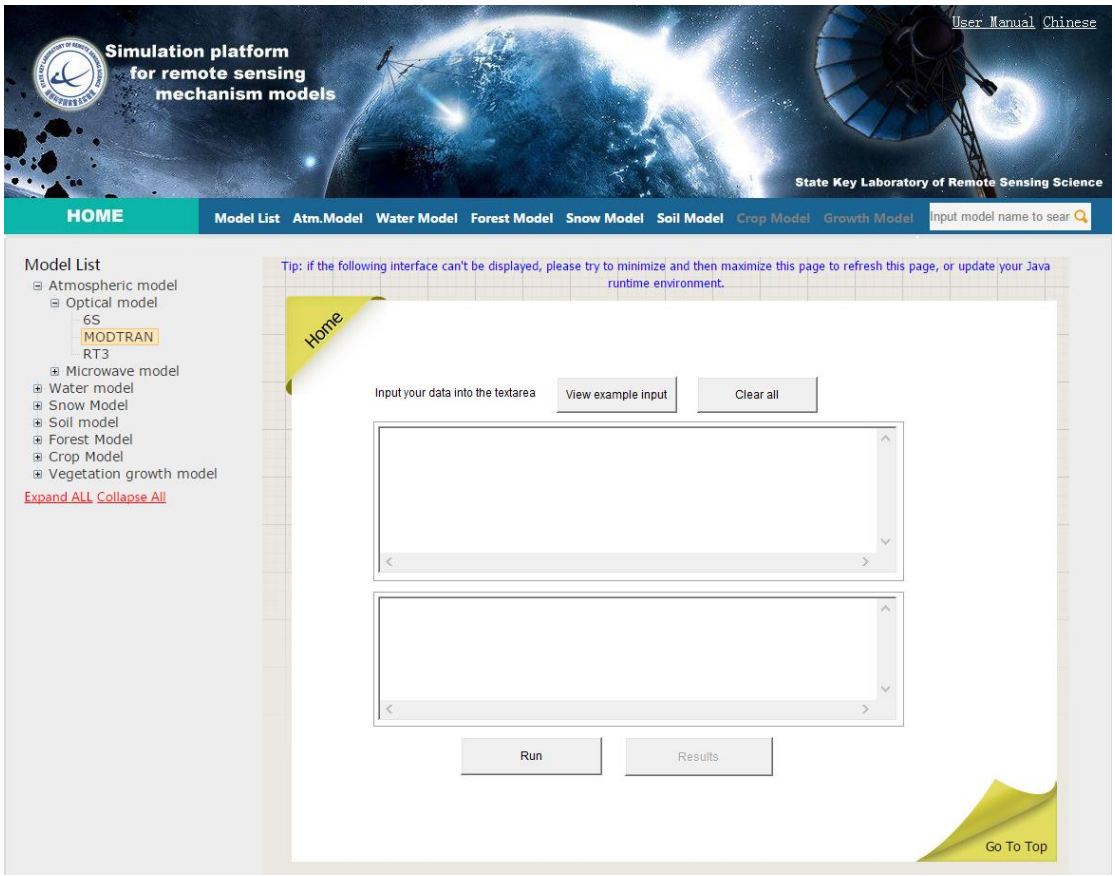


Fig 1.1.2-b Running interface of MODTRAN

Please refer to the example input as follows(which can be copied to the textarea on the previous page)

```
T   7    2    0    0    0    0    0    0    0    0    0    1    0   0.000    0.00
Pf  2T   5   360.000
    1    0    0    0    0    0     0.000     0.000     0.000     0.000     0.000
   34    1    0Radiosonde Data              0
    0.100 9.945E+02 3.103E+00 1.021E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.267 9.740E+02 2.000E+00 1.100E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.400 9.580E+02 1.200E+00-2.200E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.459 9.510E+02 1.800E+00-8.200E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.518 9.440E+02 2.200E+00-7.800E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.609 9.335E+02 1.871E+00-7.581E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.684 9.250E+02 1.600E+00-7.400E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    0.914 8.987E+02-1.647E-02-7.631E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.182 8.690E+02-1.900E+00-7.900E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.219 8.650E+02-2.067E+00-8.485E+00 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.359 8.500E+02-2.700E+00-1.070E+01 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.524 8.324E+02-3.909E+00-1.251E+01 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.632 8.210E+02-4.700E+00-1.370E+01 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.796 8.040E+02-5.700E+00-1.170E+01 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.828 8.007E+02-5.549E+00-1.407E+01 0.000E+00 0.000E+00ABG
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00
    1.923 7.910E+02-5.100E+00-2.110E+01 0.000E+00 0.000E+00ABG
```

Fig1.1.2-c example for inputting parameters to derive the model

The example file of input parameters used to derive the model appears by click on “View example input”, which is shown in Fig.1.1.2-c. The content can be copied to the text area on the previous page shown in Fig.1.1.2-b. The parameters in the example have Interpretations as follow:

Line 1: 1-5, atmosphere model (AM), 1 - tropical model, 2 - midlatitude summer model, 3 - midlatitude winter model, 4 - subarctic summer model, 5 - subarctic winter model, 6 - U.S. standard 1976, 7 – user define; **6-10,** type of path, 1 – horizontal, 2 – slant path, 3 – slant path to ground or space;

Line 2: 11-20, CO2 mixing ratio; **21-30**, scaling factor for water vapor column; **31-40**, scaling factor for Ozone column;

Line 3: 1-5, aerosol model, 0 – no aerosol , 1 – Rural-VIS=23km, 2 – Rural-VIS=5km; **21-25**, Cloud/Rain extension, 0 – no cloud free; other parameters use the default value.

Line 4: when AM=7, **1-5,** atmosphere layer number; **5-10**, 1- supply molecular density by

layer; **15-40,** title; if layer number is 34, the next 34 lines are user defined profiles of atmosphere trace gasses.

3th line from bottom: 1-10, observer height; **11-20**, final height; **21-30,** zenith angle;

2th line from bottom: 1-10, initial frequency; **11-20**, final frequency; **21-30**, frequency increment; **31-40**, Full Width at Half Maximum.

Fig.1.1.2-d gives an example of the model input parameters, choosing standard atmosphere model US1976. Then run the model by clicking “Run” (Fig.1.1.2-e). Result is saved as \Usr\MODOUT2.dat.

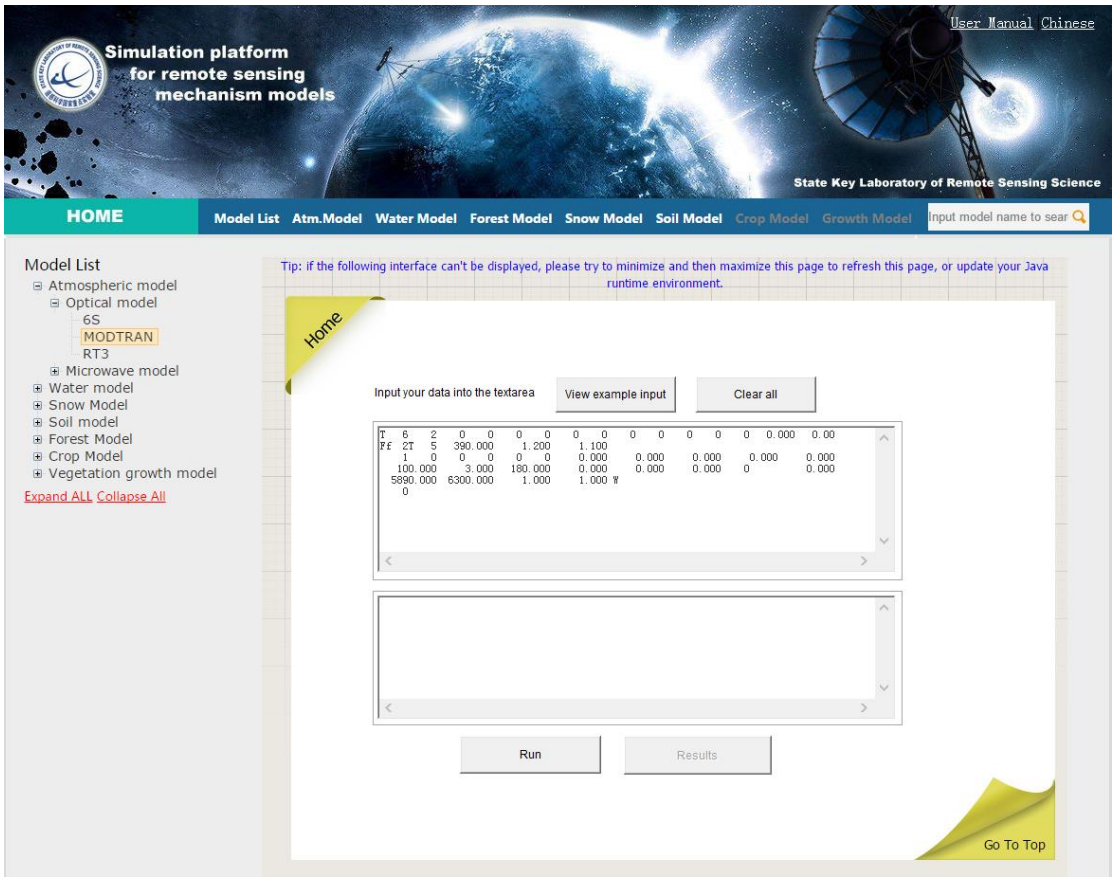


Fig 1.1.2-d example of model input parameters

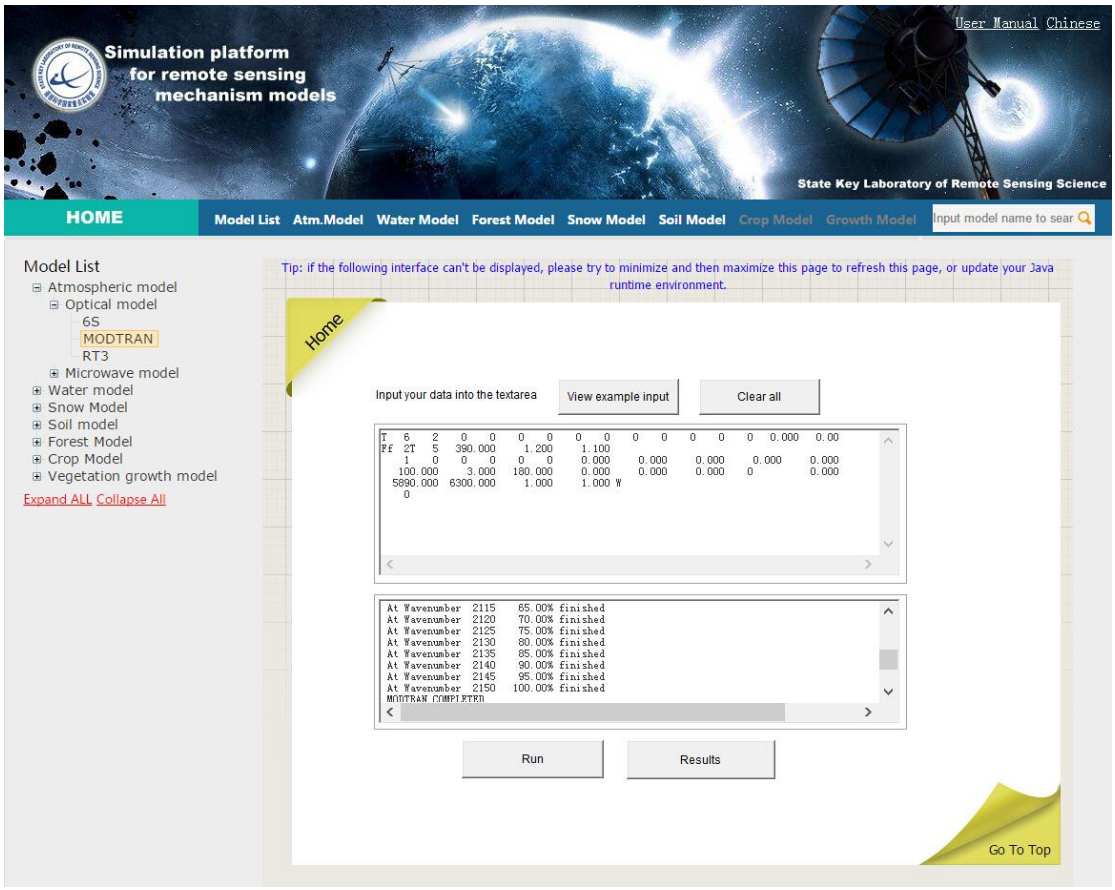


图 1.1.2-e Model calculating interface

1.1.3 RT3

(1) Brief Introduction

RT3 is a numerical model that solves the polarized radiative transfer equation for a plane-parallel, vertically-inhomogeneous scattering atmosphere. It is developed by Frank Evans at Colorado State University and the University of Colorado. The full polarization characteristics of randomly-oriented particles with any shape having a plane of symmetry are taken into account. Both thermal sources and a collimated (solar) source of radiation are included in the formulation. The angular field of the radiation is represented with a Fourier series in azimuth angle and discretization of zenith angle. The model calculates the monochromatic polarized radiation emerging from an atmosphere and is hence best suited for use in remote sensing applications. The solution method for the multiple-scattering aspect of the problem is that of doubling and adding. This approach computes the radiative properties of the medium rather than the radiance field itself so that radiances exiting the atmosphere may be easily found for many boundary conditions after the solution is computed.

Reference

Evans, K.F., & Stephens, G.L. (1991). A NEW POLARIZED ATMOSPHERIC RADIATIVE-TRANSFER MODEL. Journal of Quantitative Spectroscopy & Radiative Transfer, 46, 413-423

Cheng, T.H., Gu, X.F., Chen, L.F., Yu, T., & Tian, G.L. (2008). Multi-angular polarized

characteristics of cirrus clouds. Acta Physica Sinica, 57, 5323-5332

(2) Operation instruction

It is easy to find the RT3 in the listed atmospheric model. The meta-data are classified into the Primary information, the Parameters, the References, the Equation, and the Service(Fig.1). The URL to visit the web-service of the model can be found in the "Service"tab (Fig.2), and you can follow the instructions on the interface to run the model (Fig.3).

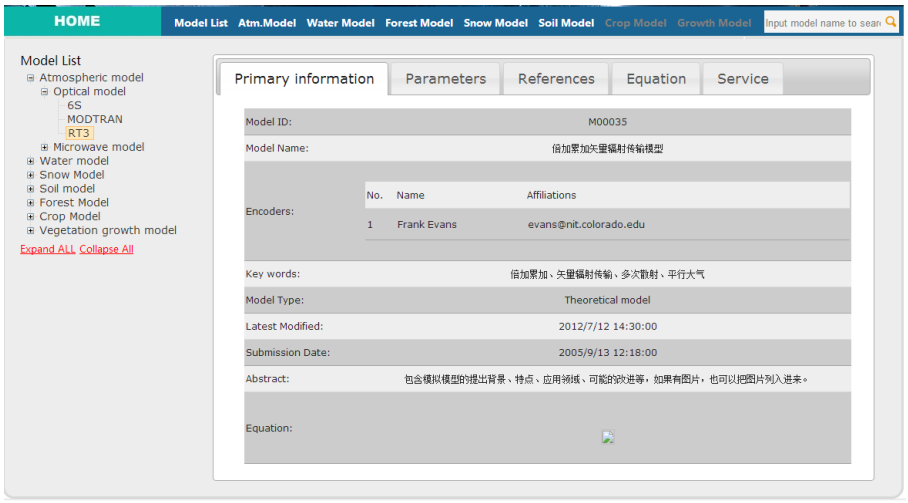


Figure 3 the interface of RT3

Some of the input parameters are described as followed：

1） NSTOKES:Number of Stokes parameters (1 - 4);

2） NUMMU: Number of quadrature directions;

3） Type of quadrature : Gaussian, Double-Gauss, Lobatto, Extra-angles;

4） Delta-M scaling:Y or N;

5） Ground type: Lambertian or Fresnel;

6） Output radiance units : W-W/m^2 um sr and T-EBB brightness temperature, R-Rayleigh-Jeans Tb

7） Output polarization:IQ or VH;

Fig gives an example of the model input parameters, Then run the model and the result can be output as a graph or the txt file.

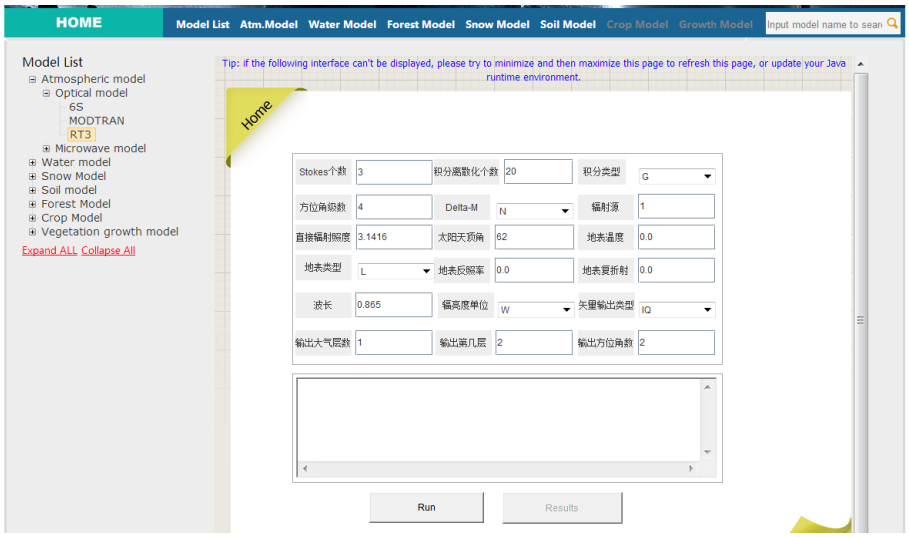


Figure 4 The running interface of RT3

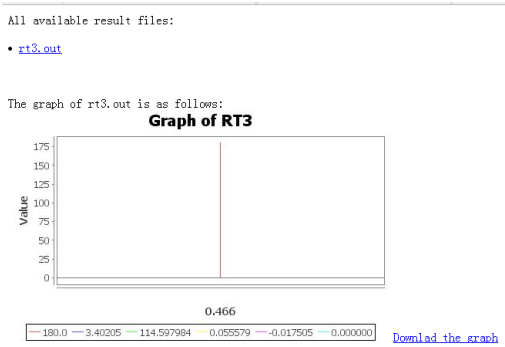


Figure 5 An example the output graph

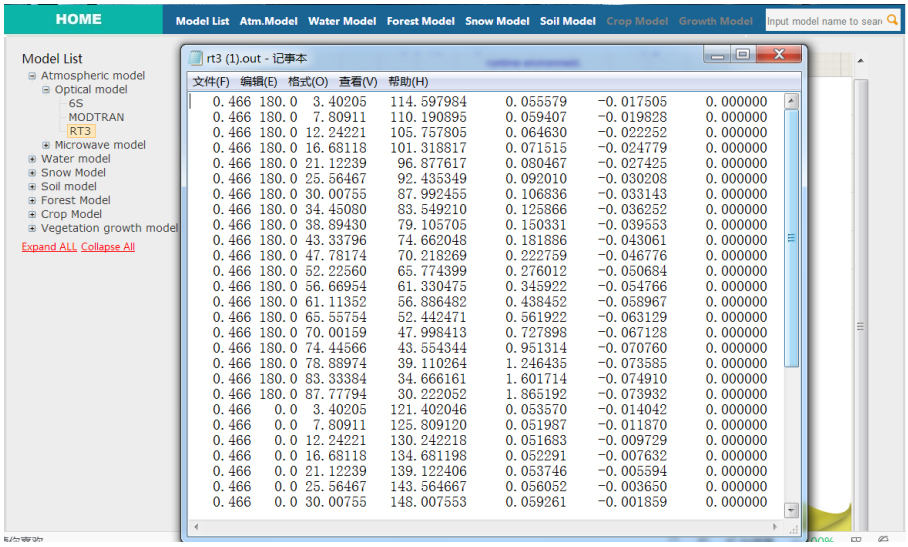


Figure 6 An example of the output result

In the output result, the column 1-3 from left to right are the height, azimuth angle and zenith angle respectively; the last three columns are the corresponding Stokes parameters of I, Q and U.

1.1.4 1DMWRTM

（1）Brief Introduction

In the retrieval of atmospheric parameter using microwave radiometer, atmospheric radiative transfer model in microwave bands is the necessary. The model is mainly used to simulate attenuation and contribution of atmosphere constituents to microwave signal. It is necessary to precisely simulate the radiative transfer process of microwave signal in atmosphere in the retrieval of land surface and atmosphere parameter using passive microwave remote sensing. One dimensional atmospheric microwave radiative transfer model (1DMWRTM) is mainly used in retrieval of precipitation, the model describes the micro-physic property of ice melting-layer in atmosphere and its radiative transfer property in microwave bands. The model is formatted into isotropic atmosphere data cube, and complete the simulation according to a point by point calculating using the input atmospheric profiles data. Although simplified, the model yields the volume fractions of ice, air, and liquid water of melting particles of all species and sizes at a fine grid spacing in the vertical. In addition, it's very easy to modify the instrument parameters and atmospheric parameters; and the radiative transfer property at the top of atmosphere or in the vertical can be detailed simulated by importing of profiles of temperature, humidity, cloud, rain and ice etc. The surface boundary condition can also be replaced by the output of other related surface model to further improve the ability of simulation of the model.

Reference

Olson, W. S., P. Bauer, C. D. Kummerow, Y. Hong and W. K. Tao, A melting-layer model for passive/active microwave remote sensing applications. Part II: Simulation of TRMM observations. Journal of Applied Meteorology. 2001a; 40(7):1164–1179.

Olson, W. S., P. Bauer, N. F. Viltard, E. E. Johnson, W. K. Tao, R. Meneghini and L. Liao, A melting-layer model for passive/active microwave remote sensing applications. Part I: Model formulation and comparison with observations. Journal of Applied Meteorology. 2001b; 40(7):1145–1163.

Kummerow, C., On the accuracy of the Eddington approximation for radiative transfer in the microwave frequencies. Journal of Geophysical Research-Atmospheres. 1993, 98(D2):2757-2765.

(2) Operation Instruction

The current version of the model is only applicable to AMSR-E. The model calculates brightness temperature observed by AMSR-E at top of atmosphere according to the input of surface parameters and the corresponding atmospheric profile.

The basic information of the model can be find by following hyper link Atm.Model->Microwave Atm.Model->1DMWRTM, as is shown in figure 1.1.4-a, other information of the model can be acquired by click the left tabs in the page. By clicking the Service tab, users can be guide to parameters setting page of the model, the page is shown in figure 1.1.4-b. The setting of the input parameters are described in the following content.

The first parameter is surface temperature in unit of K.

The second parameters are surface emissivity corresponding to each band of AMSR-E.

The third parameter is layer number of the atmosphere, the value can be change by ‘Add layers’ button.

The fourth parameters are atmospheric profiles, the number of layers is set by the third parameter. All the profiles are read into the model from bottom of atmosphere to the top of it. Profiles that needed to be set including: Height profile (km), atmospheric relative humidity profile (%), atmospheric temperature profile (K), atmospheric pressure profile (hPa), cloud liquid water profile (g/m3), rain profile (g/m3), snow profile (g/m3), cloud ice profile (g/m3), graupel profile (g/m3), hail profile (g/m3) and Atmosphere layer number.

Users can run the model by click the button ‘Run’ after all the parameters are set, and the model will output running information in display window (Fig 1.1.4-c). The final output of the model is brightness temperature of AMSR-E at each band, and the outcome is stored in file ‘Out_Simulated_Brightness_Temperature.txt’, this file can be downloaded by click button ‘Results’ to enter the download page, as is show in Fig 1.1.4-d. Display order of the result in the file is as follows.

Column 1: Vertical polarization of Brightness temperature at 6.925GHz
Column 2: Horizontal polarization of Brightness temperature at 6.925GHz
Column 3: Vertical polarization of Brightness temperature at 10.65GHz
Column 4: Horizontal polarization of Brightness temperature at 10.65GHz
Column 5: Vertical polarization of Brightness temperature at 18.7GHz
Column 6: Horizontal polarization of Brightness temperature at 18.7GHz
Column 7: Vertical polarization of Brightness temperature at 23.8GHz
Column 8: Horizontal polarization of Brightness temperature at 23.8GHz
Column 9: Vertical polarization of Brightness temperature at 36.5GHz
Column 10: Horizontal polarization of Brightness temperature at 36.5GHz
Column 11: Vertical polarization of Brightness temperature at 89GHz
Column 12: Horizontal polarization of Brightness temperature at 89GHz

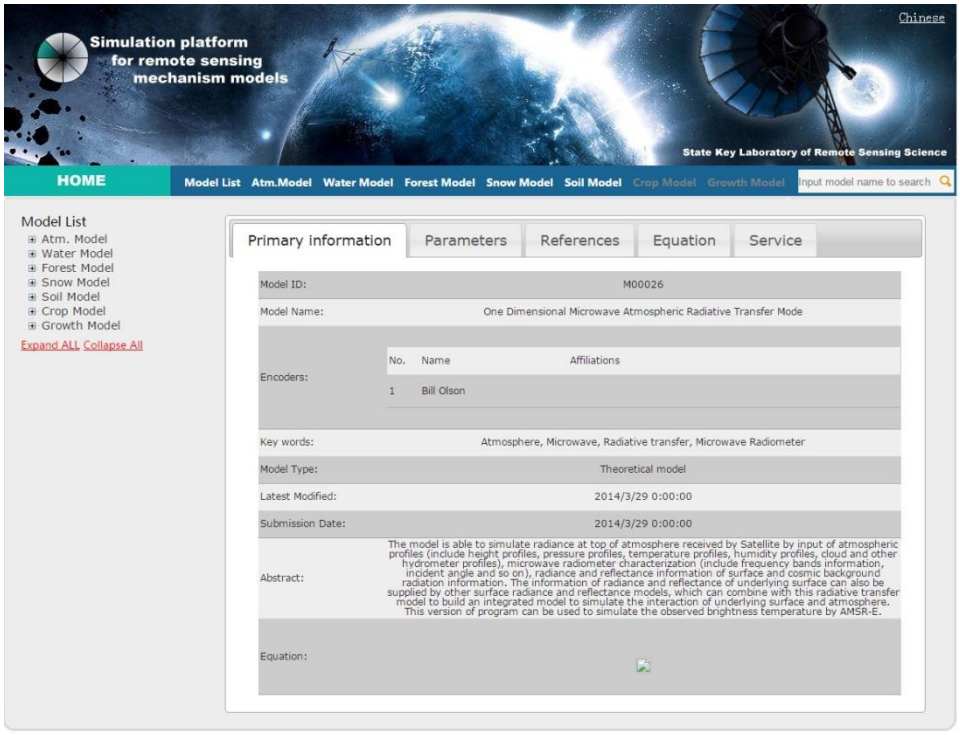

Simulation platform for remote sensing mechanism models
Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Input model name to search
Model List
Atm. Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00026
Model Name: One Dimensional Microwave Atmospheric Radiative Transfer Mode
Encoders:
No. Name Affiliations
1 Bill Olson
Key words: Atmosphere, Microwave, Radiative transfer, Microwave Radiometer
Model Type: Theoretical model
Latest Modified: 2014/3/29 0:00:00
Submission Date: 2014/3/29 0:00:00
Abstract: The model is able to simulate radiance at top of atmosphere received by Satellite by input of atmospheric profiles (include height profiles, pressure profiles, temperature profiles, humidity profiles, cloud and other hydrometer profiles), microwave radiometer characterization (include frequency bands information, incident angle and so on), radiance and reflectance information of surface and cosmic background radiation information. The information of radiance and reflectance of underlying surface can also be supplied by other surface radiance and reflectance models, which can combine with this radiative transfer model to build an integrated model to simulate the interaction of underlying surface and atmosphere. This version of program can be used to simulate the observed brightness temperature by AMSR-E.
Equation:

Fig. 1.1.4-a Basic information page of 1DMWRTM

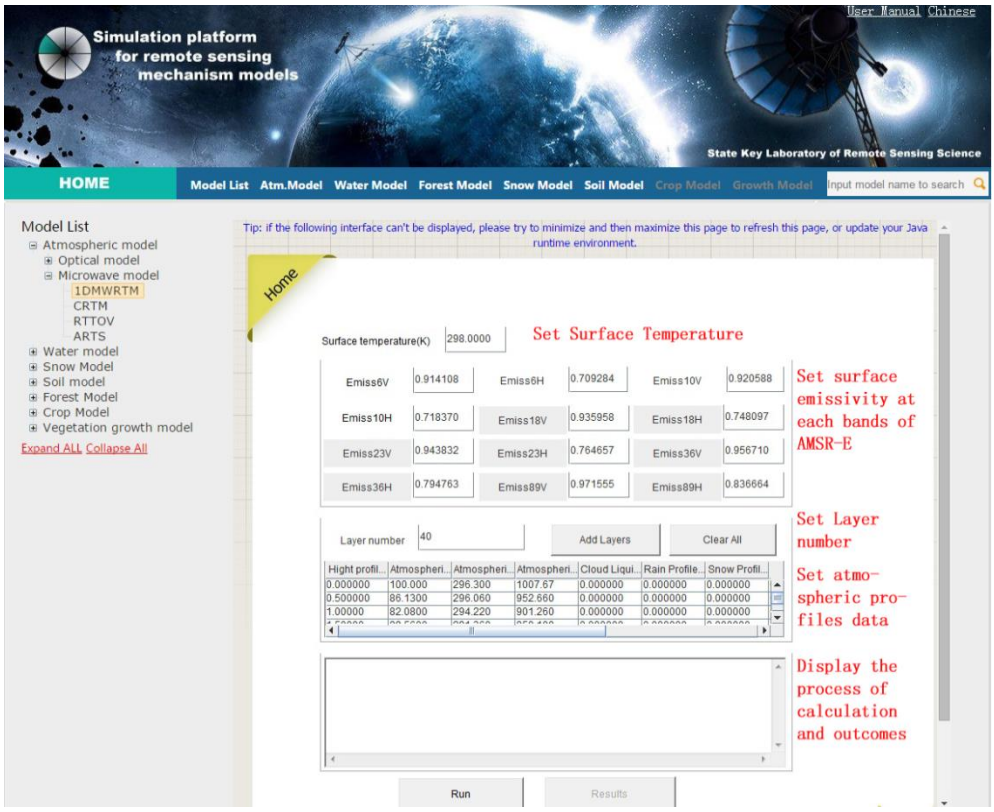


Fig.1.1.4-b Parameter setting page for running 1DMWRTM

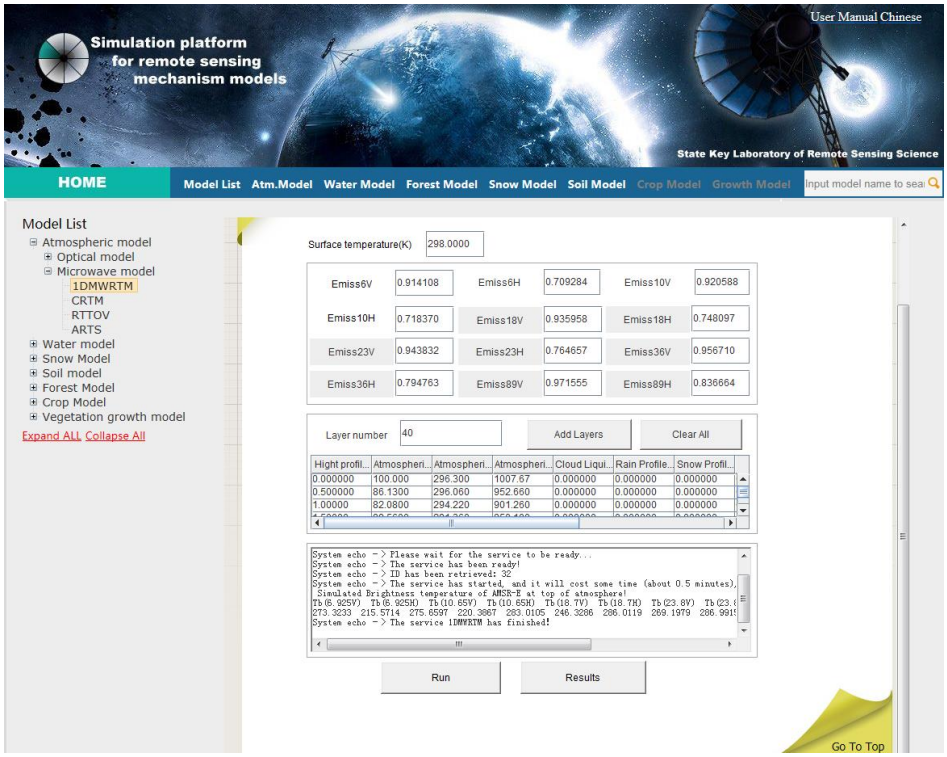


Fig.1.1.4-c The output information of 1DMWRTM during running

Fig.1.1.4-d The outcome page of 1DMWRTM

1.2 High spectral resolution model

1.2.1 Line-By-Line Radiative Transfer Model

(1) Brief Introduction

LBLRTM (Line-By-Line Radiative Transfer Model) is an accurate line-by-line model that is efficient and highly flexible.LBLRTM attributes provide spectral radiance calculations with accuracies consistent with the measurements against which they are validated and with computational times that greatly facilitate the application of the line-by-line approach to current radiative transfer applications. LBLRTM's heritage is in FASCODE [Clough et al., 1981, 1992].

Some important LBLRTM attributes are as follows:

•the Voigt line shape is used at all atmospheric levels with an algorithm based on a linear combination of approximating functions;

•extensively validated against atmospheric radiance spectra from the ultra-violet to the sub-millimeter

•the self- and foreign-broadened water vapor continuum model, MT_CKD, as well as continua for carbon dioxide; Among the other continua included in MT_CKD are the collision induced bands of oxygen at 1600 cm-1 and nitrogen at 2350 cm-1

•HITRAN line database parameters are used including the pressure shift coefficient, the half width temperature dependence and the coefficient for the self-broadening of water vapor

• a Total Internal Partition Function (TIPS) program is used for the temperature dependence of the line intensities

•CO2 line coupling is treated as first order with the coefficients for carbon dioxide generated from the code of Niro et al. (2005) and Lamouroux et al. (2010); CH4 line parameters include line coupling parameters for the v3 (3000 cm-1) and v4 (1300 cm-1) bands of the main isotopologue

References

Clough, S. A., M. W. Shephard, E. J. Mlawer, J. S. Delamere, M. J. Iacono, K. Cady-Pereira, S. Boukabara, and P. D. Brown, Atmospheric radiative transfer modeling: a summary of the AER codes, Short Communication, J. Quant. Spectrosc. Radiat. Transfer, 91, 233-244, 2005.

Clough, S.A., M.J. Iacono, and J.-L. Moncet, Line-by-line calculation of atmospheric fluxes and cooling rates:Application to water vapor.J. Geophys. Res., 97, 15761-15785, 1992.

(2) Operation Instruction

The main interface of the model is shown as Fig.1.2.1-a. The model could be launched by left click on the card “Service” and then left click on the item “Run the service”. The running interface of Line-by-line radiative transfer model is shown as Fig.1.2.1-b.

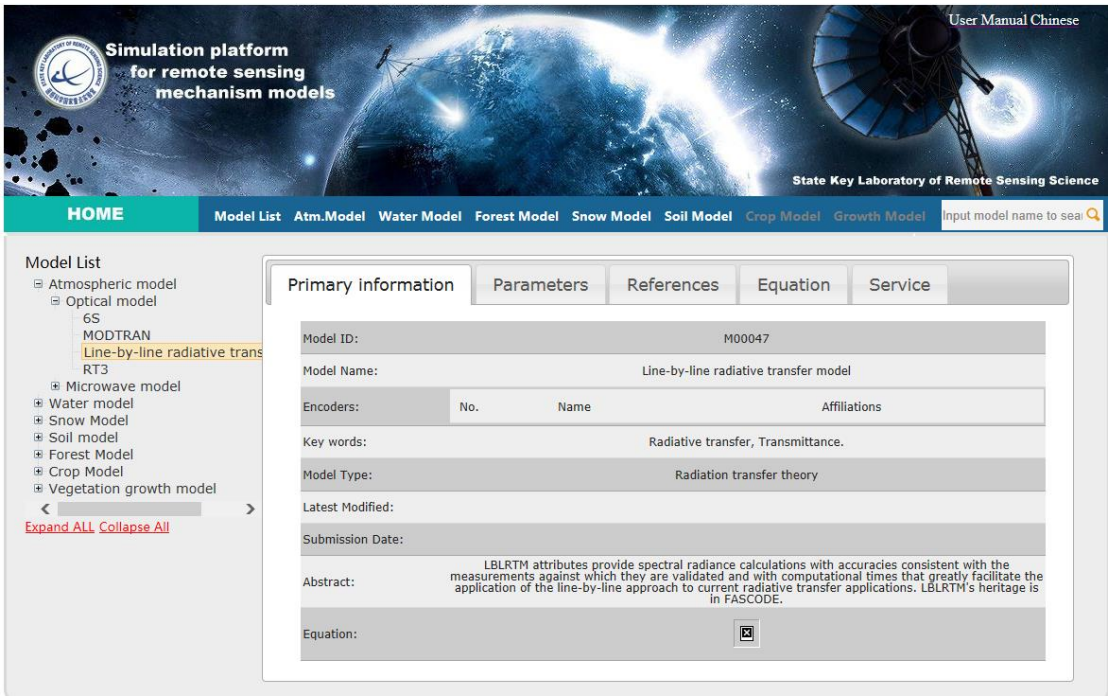


Fig1.2.1-a Main interface of Line-by-line radiative transfer mode

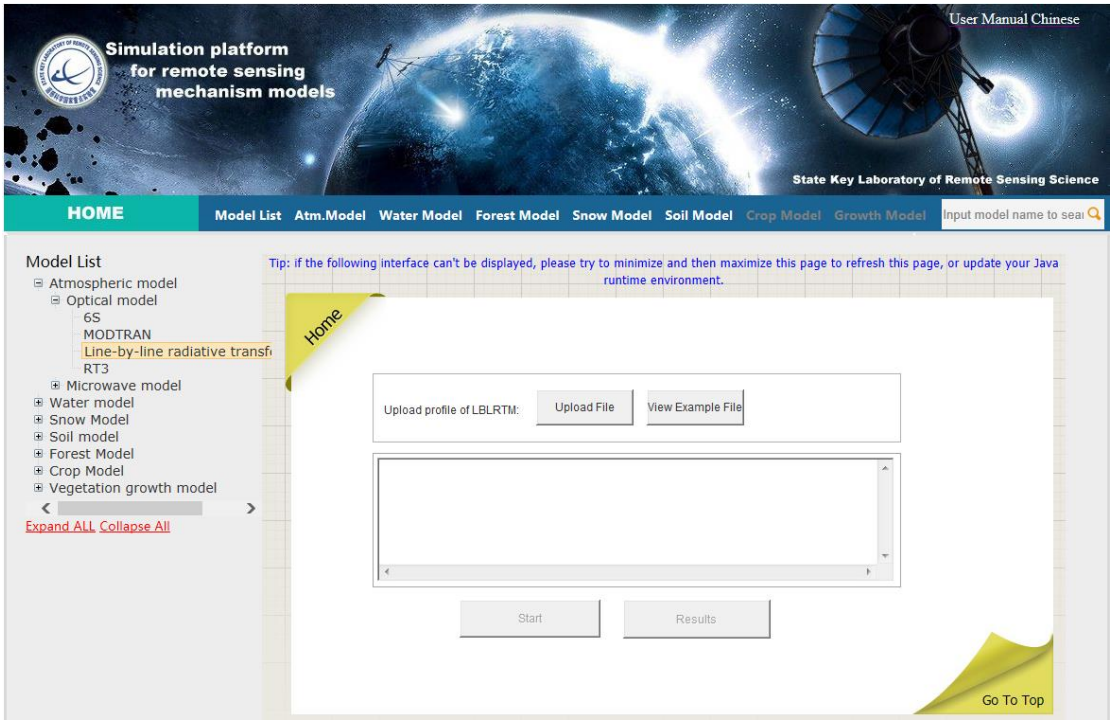


Fig1.2.1-b The running interface of Line-by-line radiative transfer model

Please refer to the following inputs, or download the **example file**

Parameters of the input:

```
$ t5ref 06/12/96 CAMEX NASA Flt #93-169 09/29/93 Wallops Island *ARM Ret O3*
 HI=1 F4=1 CN=1 AE=0 EM=1 SC=1 FI=0 PL=0 TS=0 AM=1 MG=0 LA=0 OD=0 XS=0   00    00
  15.00000  42.33333
   263.178     1.000
    6    2    0    0    0                                                  15.00
   100.000     0.000   180.000

 0.1000   15.00000  42.33333      1    2      -0.100000   12    1    1   11
-1
$ Transfer to ASCII plotting data
 HI=0 F4=0 CN=0 AE=0 EM=0 SC=0 FI=0 PL=1 TS=0 AM=0 MG=0 LA=0 MS=0 XS=0    0    0
# Plot title not used
15.00000  42.33333     10.2000  100.0000    5    0   11    0     1.000 0  0    0
    0.0000    1.2000    7.0200    0.2000    4    0    0    0    0    0 0    3 27
15.00000  42.33333     10.2000  100.0000    5    0   11    0     1.000 0  0    0
    0.0000    1.2000    7.0200    0.2000    4    0    1    1    1    0 0    3 28
-1
%%%%%
```

Fig1.2.1-c example of parameters used to derive the model

The interpretation of parameters used to derive the model will appear by click on “View Example File” as shown in Fig.1.2.1-c. Parameters used to derive the model without any interpretations will be given by further click on “example file”. It can be copied into as text file named as “in_para.txt”. The parameters in tape5.dat have Interpretations as follow:

Line3 1-10 beginning wavenumber value; 11-20 ending wavenumber value

Line4 1-10 temperature of boundary (K); 11-20 boundary emissivity

Line5 1-5 atmospheric profile model, 1 tropical model 2 midlatitude summer model 3 midlatitude winter model 4 subarctic summer model 5 subarctic winter model 6 U.S. standard 1976; 6-10 type of path, 1 horizontal path 2 slant path from H1 to H2 3 slant path from H1 to space

Line6 1-10 H1; 11-20 H2; 21-30 zenith angle at H1

Line8 1-10 Half Width Half Maximum; 11-20 beginning wavenumber value; 21-30 ending wavenumber value; 34-35 SCAN convolved with 0 transmission, 1 radiance ; 39-40 scanning function, 0 rectangular 1 triangular 2 gaussian 3 sinc squared 4 sinc 46-55 <0 the output spectral spacing

Line 13 1-10 beginning wavenumber value; 11-20 ending wavenumber value

Line 15 1-10 beginning wavenumber value; 11-20 ending wavenumber value

Line 16 55,60 is 1 when convolved with radiance; otherwise, 55,60 is 0

Go back to the running interface of the model and click on “upload file”, the interface of uploading driven file will appear as Fig. 1.2.1-d. Browse to the file “tape5.dat” and “Upload” it. Go back to the running interface and run the model by clicking on “start”. The model will run several minute according to the parameters set in the file “tape5.dat”. The item “start” will change to inactive and “Results” will change to active when the running is completed. Then click on “Results” the web page containing the file “tape27.txt”(transmission) and “tape28.txt” (radiance) will appear. Click on “tape28.txt” will see its content as Fig 1.2.1-e.

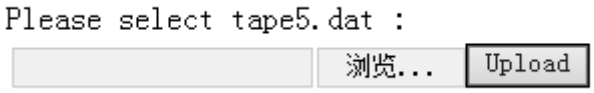


Fig1.2.1-d Interface of uploading driven file

```
1
           t5ref 06/12/96 CAMEX NASA Flt #93-169 09/29/93 Wallops Island *ARM Ret LBLRTM    15/01/06  18:00:30


 INITIAL LAYER =     1   FINAL LAYER =   44
0          SECANT =        0.00000
0          PRESS(MB) =   505.91501
0          TEMP =  250.24
0          DV =  0.10000000 CM-1
0          V1 =   15.000000 CM-1
0          V2 =   42.333330 CM-1
0
0 COLUMN DENSITY (MOLECULES/CM**2)

      OTHER =  1.698E+25
        H2O =  4.714E+22
        CO2 =  7.092E+21
         O3 =  9.247E+18
        N2O =  6.596E+18
         CO =  2.379E+18
        CH4 =  3.541E+19
         O2 =  4.492E+24
0
    IHIRAC    ILBLF4    ICNTNM    IXSECT    IAERSL     IEMIT     ISCAN     IPLOT    IPATHL      JRAD    JFNVAR      HWHM
         1         1         1         0         0         1         1         0         1         0      120.   0.10000
0     WAVENUMBER        TEMPERATURE

       15.00000000         125.91513
       15.10000001         216.01273
       15.20000002         245.44342
       15.30000001         250.40552
       15.40000004         251.56166
       15.50000006         251.25806
       15.60000002         249.25166
       15.70000005         245.87442
       15.80000007         243.31909
       15.90000010         244.87643
```

Fig 1.2.1-e Output results of LBLRTM

2. Water

2.1 Optical model

(1) Introduction of BRDF-QAA model

Morel and Gentili [1991; 1993; 1996] and Morel et al.[2002] have demonstrated that the upward radiance distribution in the water is not isotropic. They developed look-up-tables (LUT) for selected chlorophyll concentrations, wavelengths, solar zenith angles, view nadir angles and azimuth angles, however, the LUT was developed based on the Case I bio-optical models, while our approach is to describe/correct angular dependence based on IOPs. Different phase functions (a new phase function derived from the measured data by MVSM in coastal waters, the widely used Petzold average phase function, and the Fournier–Forand (FF) phase function) are employed in the simulations. In addition, the new remote-sensing reflectance model that separates the back scattering contributions into water molecular and particle parts [Lee, et al., 2004] is used.

This model was jointly developed by Prof. Zhongping Lee of UMass, Boston, Dr. Keping Du of State Key Laboratory of Remote Sensing Science etc. in 2011. Please contact Keping Du (email: kpdu@bnu.edu.cn) for further information.

References:

Lee, Z., K. Du, K. J. Voss, G. Zibordi, B. Lubac, R. Arnone, and A. Weidemann (2011), An inherent-optical-property-centered approach to correct the angular effects in water-leaving radiance, Applied Optics, 50, 3155-3167.

Du, K., and Z. Lee (2010), Phase function effects for ocean color retrieval algorithm, SPIE Remote Sensing of the Coastal Ocean, Land, and Atmosphere Environment.

(2) Brief guide

Graphic user interface (GUI) of this model is shown in Fig. 2.1-a, firstly click “Service” tab, then click “Run the service” link，GUI of the model running is shown in Fig. 2.1-b. Click the “Run” button, the model will be ran at background. When you see the message which is “The service BRDF_QAA has finished” in the information textbox, the result is displayed in the same textbox as shown in Fig. 2.1-c.

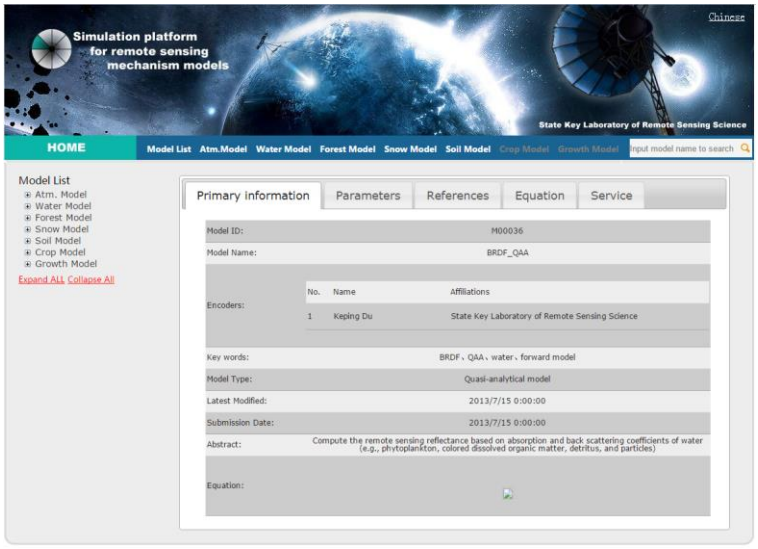

Simulation platform for remote sensing mechanism models
Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List Atm.Model Water Model Forest Model Snow Model Soil Model Crop Model Growth Model
Input model name to search
Model List
Atm. Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00036
Model Name: BRDF_QAA
Encoders:
No. Name Affiliations
1 Keping Du State Key Laboratory of Remote Sensing Science
Key words: BRDF、QAA、water、forward model
Model Type: Quasi-analytical model
Latest Modified: 2013/7/15 0:00:00
Submission Date: 2013/7/15 0:00:00
Abstract: Compute the remote sensing reflectance based on absorption and back scattering coefficients of water (e.g., phytoplankton, colored dissolved organic matter, detritus, and particles)
Equation:

Fig. 2.1-a GUI of BRDF-QAA model

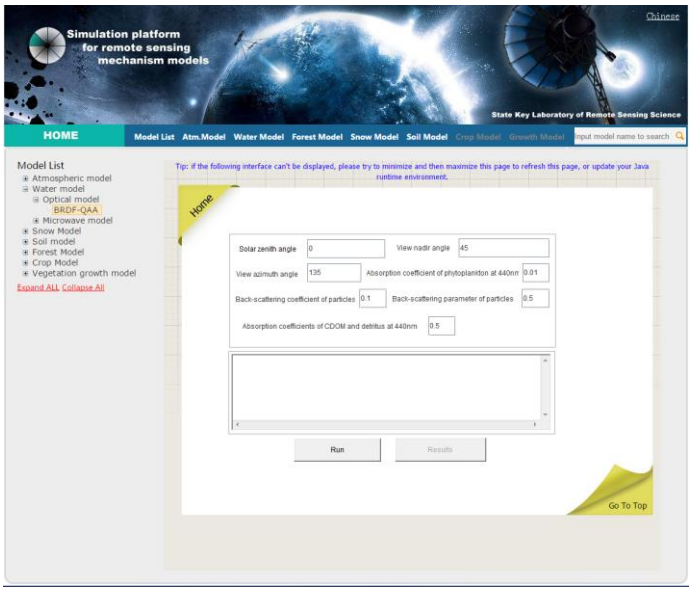

Simulation platform for remote sensing mechanism models
Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List Atm.Model Water Model Forest Model Snow Model Soil Model Crop Model Growth Model
Input model name to search
Model List
Atmospheric model
Water model
Optical model
BRDF-QAA
Microwave model
Snow Model
Soil model
Forest Model
Crop Model
Vegetation growth model
Expand ALL Collapse All
Tip: if the following interface can't be displayed, please try to minimize and then maximize this page to refresh this page, or update your Java runtime environment.
Home
Solar zenith angle 0
View nadir angle 45
View azimuth angle 135
Absorption coefficient of phytoplankton at 440nm 0.01
Back-scattering coefficient of particles 0.1
Back-scattering parameter of particles 0.5
Absorption coefficients of CDOM and detritus at 440nm 0.5
Run
Results
Go To Top

Fig. 2.1-b GUI of model running

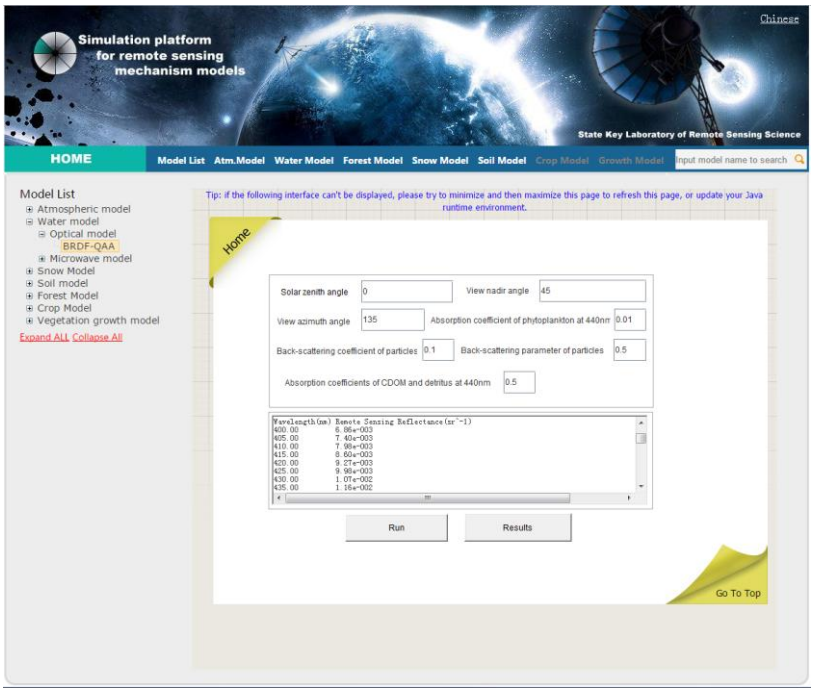


Fig. 2.1-c GUI of the model result

(3) Input parameters of model

Solar zenith angle (degree), data range: 0-90

View nadir angle (degree), data range: 0-90

View azimuth angle (degree), data range: 0-180

Absorption coefficient of phytoplankton at 440nm (m^-1), data value: >0

Absorption coefficients of CDOM and detritus at 440nm (m^-1), data value: >0

Back-scattering coefficient of particles at 550nm (m^-1), data value: >0

Back-scattering parameter of particles (dimensionless), data value: >0

2.2 Microwave model

(1) Introduction

The microwave water forward model was implemented based on the CMOD5, a new C-band geophysical model functions, derived by Hersbach et. al. (2007) and a polarization ratio model by Liu et. al., (2013) , and the precision of normalized radar cross sections (NRCS) for HH polarizations estimated by the model is improved. The forward model is developed on the basis of measurements from the scatterometer and synthetic aperture radar on board of the European Remote Sensing Satellite. It can computes C-band VV/HH Normalized Radar Cross Section (NRCS) for a specified incidence angle, radar azimuth angle, wind direction, and wind speed. The version of the model belongs to Hersbach et. al. (2007) and Liu et. al., (2013). If you have problems, please email to Wenjian Ni. The email adress is niwj@radi.ac.cn.

References

Hersbach, H., A. Stoffelen, and S. de Haan (2007), An improved C-band scatterometer ocean

geophysical model function: CMOD5, J. Geophys. Res., 112, C03006, doi:10.1029/2006JC003743.

Liu, G. H., Yang, X. F., Li, X. F., Zhang, B., Pichel, W., Li, Z. W., & Zhou, X. (2013). A Systematic Comparison of the Effect of Polarization Ratio Models on Sea Surface Wind Retrieval From C-Band Synthetic Aperture Radar. *Ieee Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *6*(3), 1100-1108. doi: Doi 10.1109/Jstars.2013.2242848

(2) User manual of the model

The main interface of the model is shown in figure 2.2-a. One can open a run widow for the model by clicking the “Service” tab page and then click the “Run the service” on the tab, shown in figure 2.2-b. Click the “Start” button on the service window. According to the prompt information given on the message window, input the parameter value in the text box below the message window, and then confirm by clicking the “Submit” button. For example, inputting the value of wind speed 10, wind direction 0, incidence angel 30 and azimuth angle 0, the results of the model are shown in the figure 2.2-c. They are the values of the VV and HH Normalized Radar Cross Section in dB estimated by the model in the above given condition.

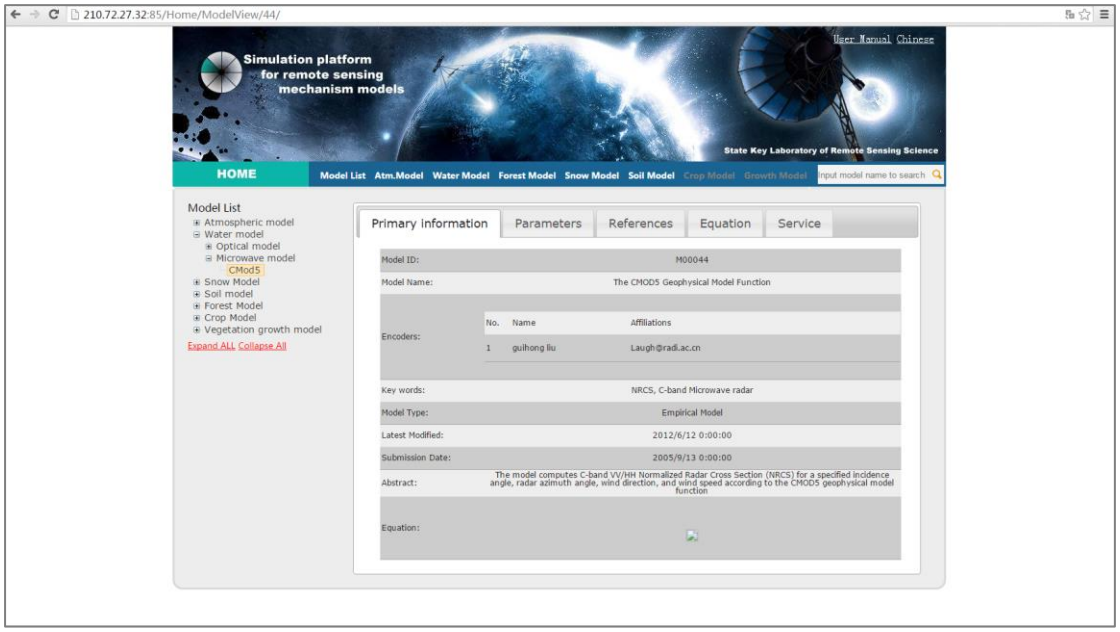


Figure 2.2-a The main interface

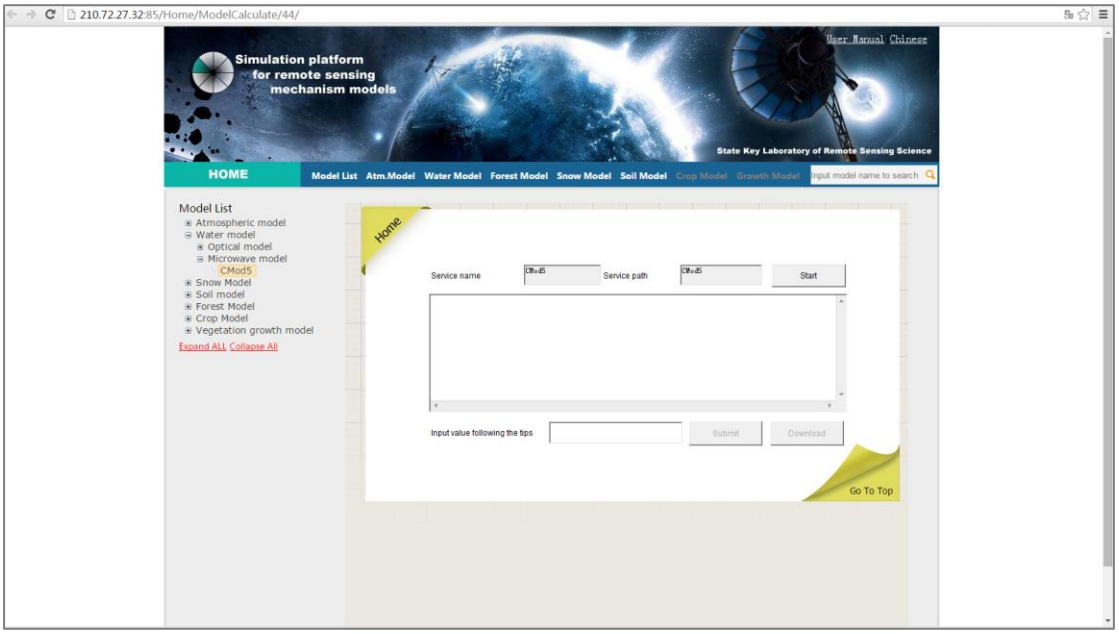


Figure 2.2-b The main interface of running the Service

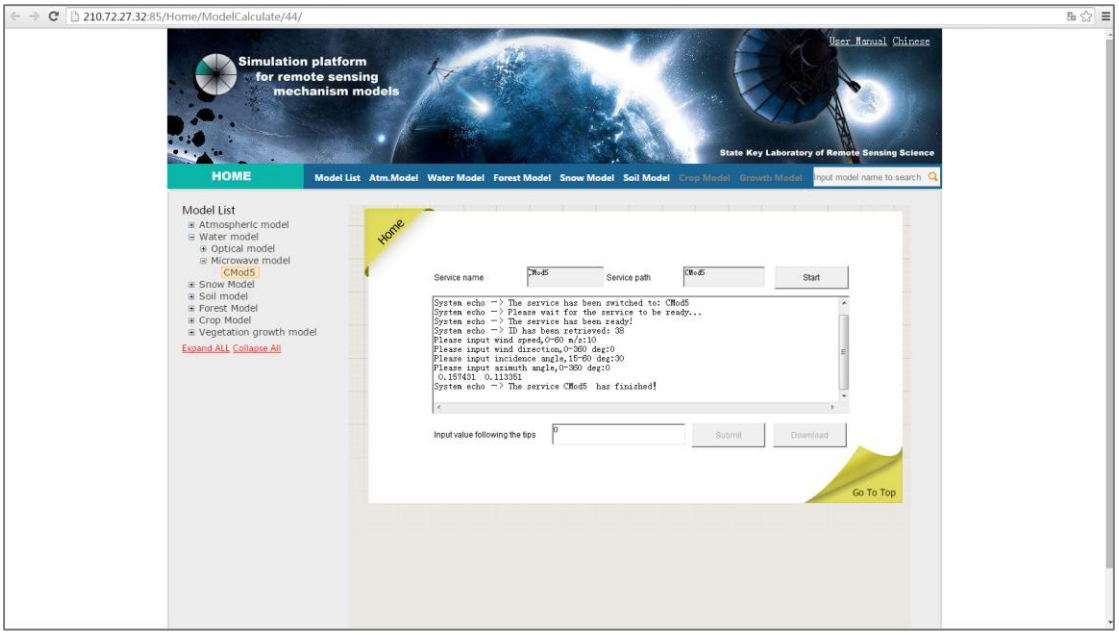


Figure 2.2-c The results of the model

(3) Input and output Variables

The input parameters of the model include:

Incidence angle in degree 15-60

Radar illumination azimuth angle relative to north in degree 0-360

Wind speed in m/s 0-60

Wind direction relative to north in degree 0-360

The output products of the model include the values of the VV and HH Normalized Radar Cross Section in dB.

3. Snow

3.1 Passive microwave model

3.1.1 DMRT-MD-AIEM snow microwave emission model

(1) Introduction to model

This model uses the matrix doubling approach to include incoherent multiple-scattering in the snow, and the model combines the Dense Media Radiative Transfer Model (DMRT) for snow volume scattering and emission with the Advanced Integral Equation Model (AIEM) for the randomly rough snow/ground interface to calculate dry snow emission signals. Please refer to the references for details.

References:

[1]. Jiang Lingmei，Passive Microwave Remote Sensing of Snow Water Equivalent Study，Beijing Normal University, Ph.D thesis, 2005

[2]. Jiang L, Shi J, Tjuatja S, et al. A parameterized multiple-scattering model for microwave emission from dry snow. Remote sensing of Environment, 2007, 111(2): 357-366.

[3]. Fung, K. (1994), Microwave Scattering and Emission Models and Their Applications. Norwood, MA: Artech House.

[4]. Tjuatja, S., Fung, A.K., & Dawson, M.S. (1993), An Analysis of Scattering and Emission from Sea Ice, Remote Sensing Reviews, 7, 83-106.

(2) The quick guide of the model

The GUI of the model is shown as in Fig. 3.1.1.a. Click on the “Service” tab, and click on the link of “run the service” to initialize the running of the model. Then fill out the forms to provide the input parameters of the model, shown as Fig. 3.1.1.b

The input parameters include:

“incident angle(Degree)”: the incidence angle in degree;

“Observing frequency”: The observation frequency in GHz;

“Snow depth”: snow depth in meter;

“Snow density”: snow density in g/cm^3;

“Radius(mm)” : snow grain radius in mm;

“Snow wetness”: volume fraction of liquid water content in snow layer;

“RMS height” : ground surface rms height in cm;

“Correlation length”: ground surface correlation lengh in cm;

“Soil moisture”: ground surface volume soil moisture;

“Snow temperature”: the snow temperature in °C.

“Temperature”: the average temperature in °C.

“Soil temperature”: the soil temperature in°C .

Then click on the “Run” button to start running the model. When the calculation completed, click on the “Results” button to see the simulation results.

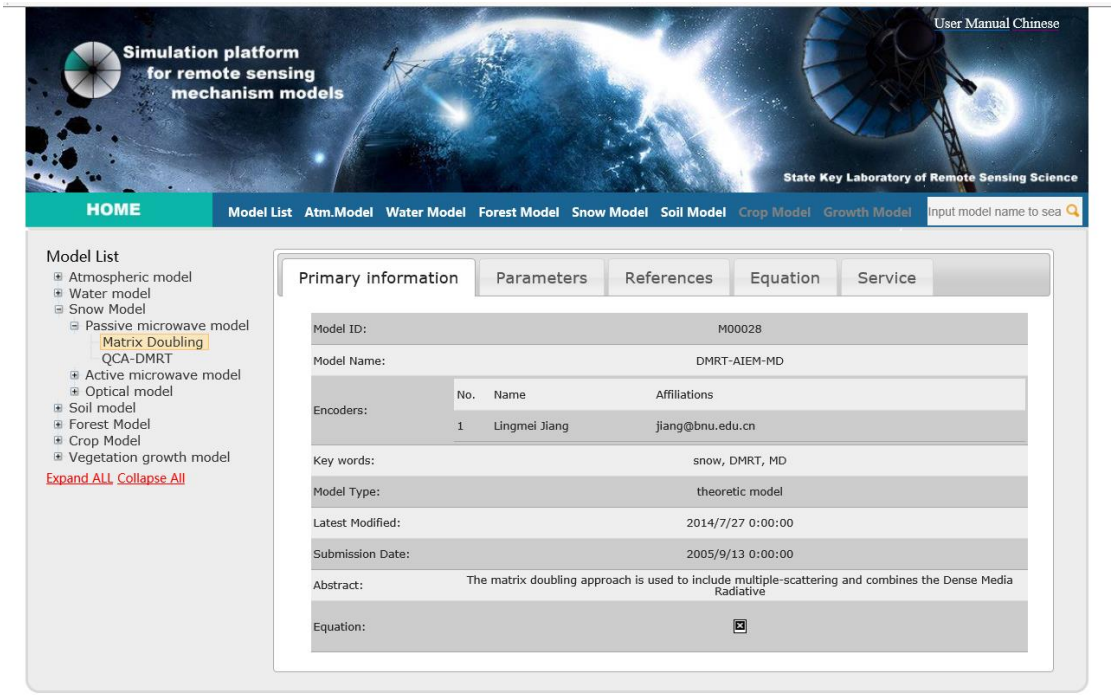


Fig. 3.1.1.a The GUI of the model service

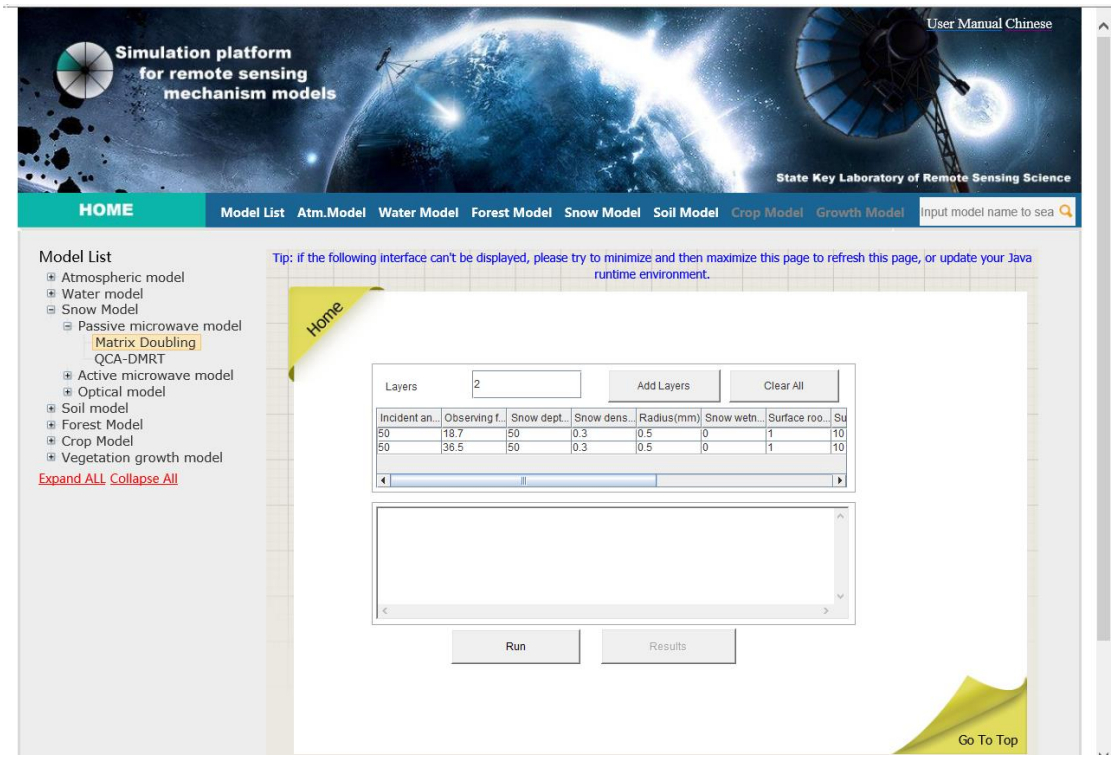


Fig. 3.1.1.b The input parameters of model

3.1.2 Multi-layer passive DMRT-QCA snow microwave emission model

(1) Introduction to model

The multi-layer passive DMRT-QCA snow microwave emission model is based on the theory and model of Prof. Leung Tsang of University of Washington. The collective scattering effect and multiple scattering effect of snow particles are considered in the model based on dense media scattering theory. The interaction of different snow layers is also considered based on the multi-layer radiative transfer model. The snow-soil interface is modeled as flat surface, or modeled as rough surface based on AIEM model or empirical model. In the model, the effect of liquid water is added, the liquid water is considered as water coated ice particle. The simulation of dry snow can be simply achieved by setting the liquid water content as 0. Please refer to the references for details.

References:

L. Tsang, C. T. Chen, A. T. C. Chang, J, Guo and K. H. Ding, "Dense Media Radiative Transfer Theory Based on Quasicrystalline Approximation with Application to Passive Microwave Remote Sensing of Snow", Radio Science, Radio-Science. vol.35, no.3;; p.731-49, May-June 2000

L. Ding, X. Xu, L. Tsang, K. M. Andreadis and E. G. Josberger, " Multi-layer Effects in Passive Microwave Remote Sensing of Dry Snow Using Dense Media Radiative Transfer Theory (DMRT) Based on Quasicrystalline, " IEEE Trans. Geosci. Remote Sens., vol. 46, no. 11, pp. 3663-3671, Novermber 2008. 2008

K. S. Chen, T. D. Wu, L. Tsang, Q. Li, J. Shi, and A. K. Fung, "The emission of rough surfaces calculated by the integral equation method with a comparison to a three-dimensional moment method simulations", IEEE TGRS, vol. 41, no. 1, pp.90 - 101, 2003.

(2) The quick guide of the model

The GUI of the model is shown as in Fig. 3.1.2.a. Click on the “Service” tab, and click on the link of “run the service” to initialize the running of the model. Then fill out the forms to provide the input parameters of the model, shown as Fig. 3.1.2.b

The input parameters include:

“initial incident angle(Degree)”, “End of incident angle(Degree)”, and “Step of the incident angle(Degree)”;

“Frequency”: The observation frequency in GHz;

“Snow layers”: number of snow layers;

Then input the snow parameters of each snow layer in the table below:

“Snow density”: in kg/m^3;

“Snow grain radius” : in mm;

“Stickiness”: QCA theory stickiness parameter;

“Snow temperature”: in K;

“Snow liquid water content”: volume fraction of liquid water content in snow layer;

“Snow layer depth”: in meter;

Then input the soil parameters:

“Soil model”: “Flat” means the soil surface is considered as flat in solving the boundary condition of radiative transfer equation, “AIEM” means the AIEM model is used to

calculate the reflectivity of soil surface in solving the boundary condition of radiative transfer equation, “Empirical” means the semi-empirical model is used to calculate the reflectivity of soil surface in solving the boundary condition of radiative transfer equation.

“Soil moisture”: in %;

“RMS height” and “Correlation length”: in cm;

“Correlation function”: select from the drop-down menu;

“Soil temperature”: in K.

Then click on the “Run” button to start running the model.

When the calculation completed, click on the “Results” button to see the simulation results, as shown in Fig. 3.1.2.c. The X-axis is the observation angle in degree, the Y-axis is the H and V polarization microwave brightness temperature in Kelvin. Click on the file names to download the results in to your local computer.

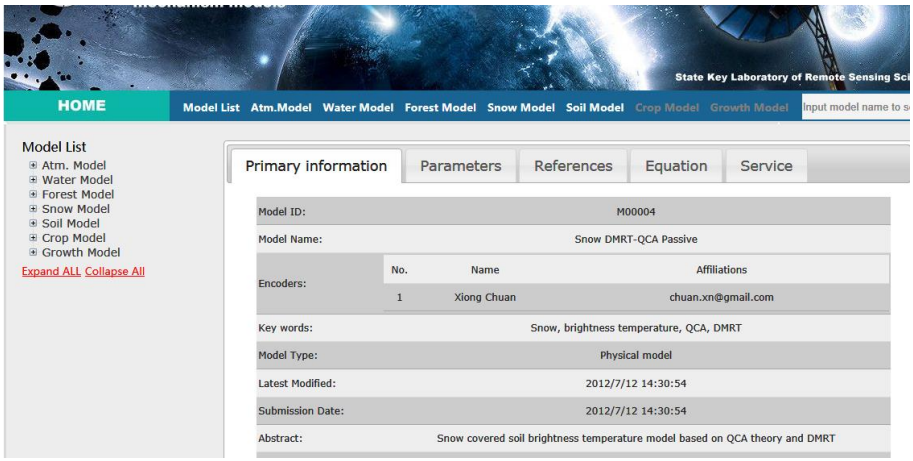


Fig. 3.1.2.a The GUI of the model service

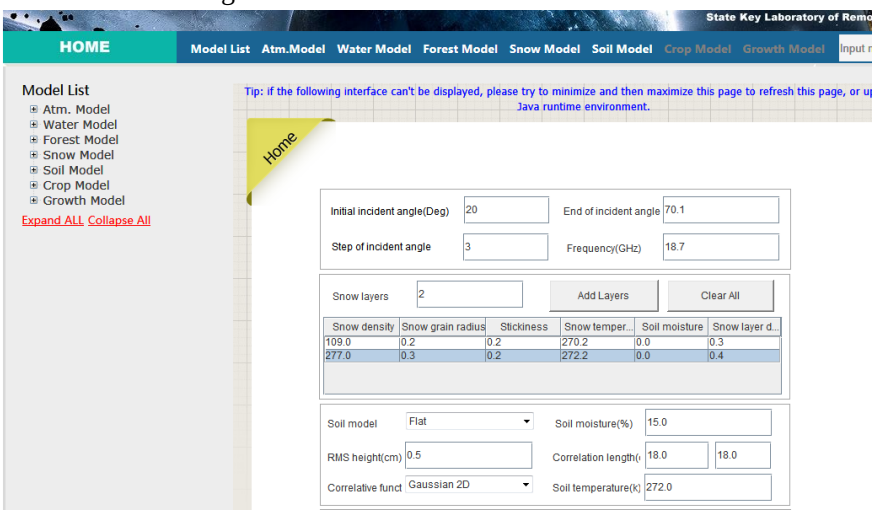


Fig. 3.1.2.b The input parameters of model

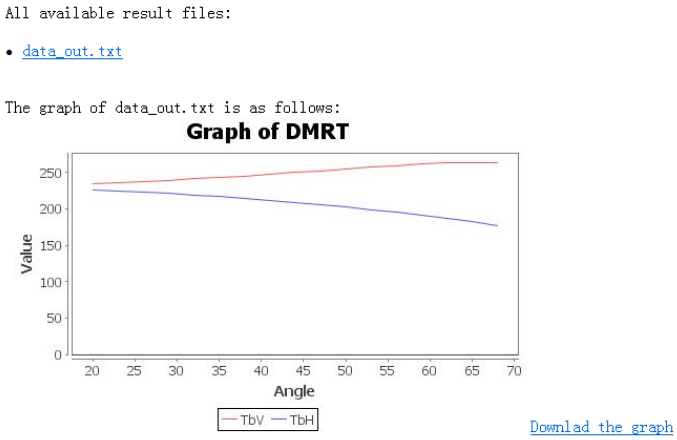


Fig. 3.1.2.c The simulation results.

3.2 Active microwave model

3.2.1 Multi-layer active DMRT-QCA snow microwave scattering model

（1）Introduction of the model

The active multilayer DMRT-QCA snow backscattering model is proposed by Prof. Leung Tsang of University of Washington. In the model, the collective scattering effect, multiple scattering effect are considered based on the QCA theory, and the multi-layer effect of the snow scattering is considered by solving multi-layer radiative transfer theory. The multi-layer vector radiative transfer equation is solved by solving a system of boundary conditions of nearby snow layers. The snow-soil rough surface scattering is simulated using the AIEM model, the cross-polarization snow-soil interface backscattering is simulated using the semi-empirical Oh model. Please refer to the references for details.

References：

L. Tsang, J. Pan, D. Liang, Z. X. Li, D. Cline, and Y. H. Tan, “Modeling active microwave remote sensing of snow using dense media radiative transfer (DMRT) theory with multiple scattering effects,” IEEE Transactions on Geoscience and Remote Sensing, vol. 45, no. 4, pp. 990-1004, April 2007.

L. Ding, X. Xu, L. Tsang, K. M. Andreadis and E. G. Josberger, " Multi-layer Effects in Passive Microwave Remote Sensing of Dry Snow Using Dense Media Radiative Transfer Theory (DMRT) Based on Quasicrystalline, " IEEE Trans. Geosci. Remote Sens., vol. 46, no. 11, pp. 3663-3671, Novermber 2008. 2008

K. S. Chen, T. D. Wu, L. Tsang, Q. Li, J. Shi, and A. K. Fung, "The emission of rough surfaces calculated by the integral equation method with a comparison to a three-dimensional moment method simulations", *IEEE TGRS*, vol. 41, no. 1, pp.90 - 101, 2003.

(2) User guide of the model simulation service

The GUI of the model is shown as in Fig. 3.2.1.a. Click on the “Service” tab, and click on the link of “run the service” to initialize the running of the model. Then fill out the forms to provide the input parameters of the model, shown as Fig. 3.2.1.b

The input parameters are:

"Initial incident angle", "End of incident angle", "Step of incident angle": in degree;

"Polarization angle": two angle parameters to control the polarization of incident wave, 0 and 0 indicate V polarized incidence, 180 and 0 indicate H polarized incidence;

"Frequency": incident wave frequency in GHz;

"Snow layer number": number of snow layers;

Then input the snow parameters of each snow layer in the table below:

"Snow density": in kg/m^3;

"Snow grain radius" : in mm;

"Stickiness": QCA theory stickiness parameter;

"Snow temperature": in K;

"Snow layer depth": in meter;

Then input the soil parameters:

"Soil moisture": in %;

"RMS height" and "Correlation length": in cm;

"Correlation function": select from the drop-down menu;

Then click on the "Run" button to start the model simulation. When the simulation completed, click on the "Results" to see the simulation results, as shown in Fig. 3.2.1.c. The X-axis is the incident angle in degree, the Y-axis is the polarized microwave backscattering coefficient (sigma0). Click on the file names to download the results in to your local computer.

If the "polarization angles" are set to be 0 and 0, the model will simulate the VV and HV polarization backscattering coefficient. In this case, the VV and HV in the result file stand for total VV and HV backscattering coefficient respectively, the volume_VV and volume_HV stand for snow volume VV and HV backscattering coefficient respectively, and the soil_VV and soil_HV stand for soil surface VV and HV backscattering coefficient respectively.

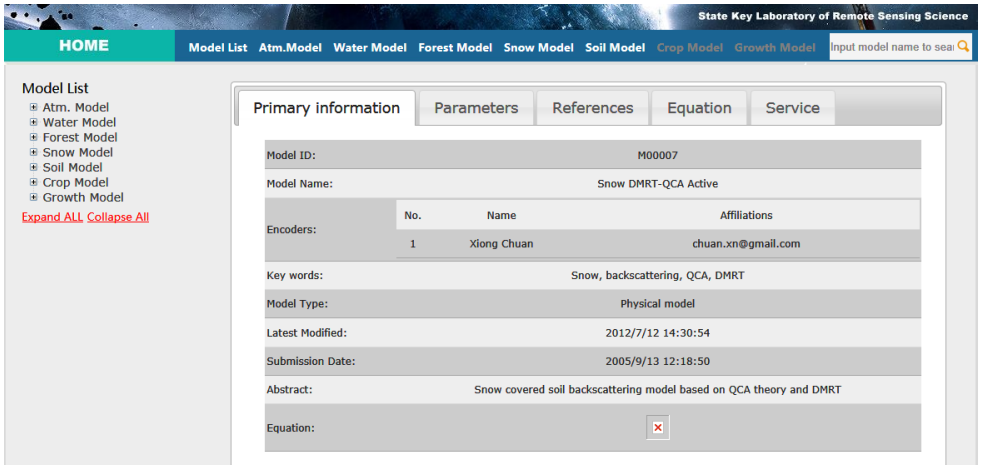


Fig. 3.2.1.a The GUI of the model serivice

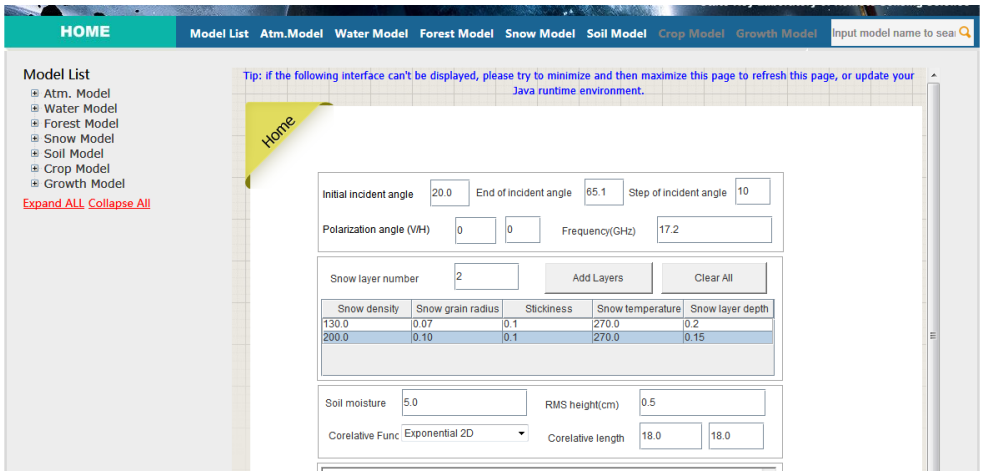


Fig. 3.2.1.b The input parameters

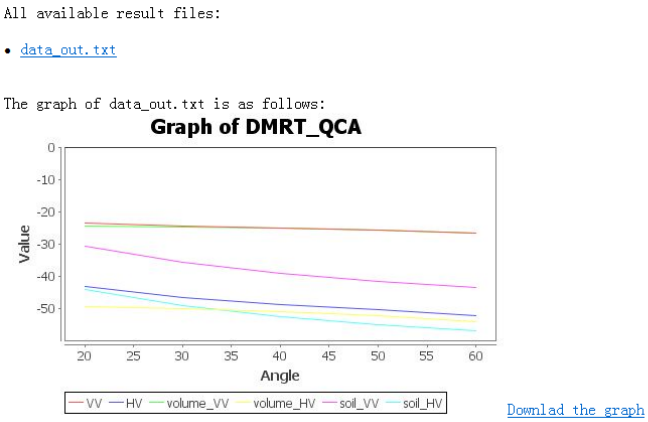


Fig. 3.2.1.c The model results

3.3 Optical model

3.3.1 Ray-tracing-bicontinuous model

(1) Introduction of the model

This model provides capability of simulating the optical reflectance of snow surface. Based on computer generated complex and random snow microstructure, the reflectance is simulated using ray tracing technique. In this model, the snow microstructure is modeled using the bicontinuous medium, which has greater similarity with real snow microstructure compared to traditional models, such as the models based on Mie theory. Because the bi-directional simulation is very time-consuming, here we only provide the service of simulating hemispherical reflectance. Please refer to the references for details.

References:

Chuan Xiong, Jiancheng Shi, Simulating polarized light scattering in terrestrial snow based on bicontinuous random medium and Monte Carlo ray tracing, *Journal of Quantitative Spectroscopy and Radiative Transfer*, Volume 133, Pages 177-189, January 2014, ISSN 0022-4073, http://dx.doi.org/10.1016/j.jqsrt.2013.07.026.

(2) User guide of the model

The GUI of the model is shown as in Fig. 3.3.1.a. Click on the “Service” tab, and click on the link of “run the service” to initialize the running of the model. Then fill out the forms to provide the input parameters of the model, shown as Fig. 3.3.1.b

The input parameters include:

“Monte Carlo superposition”: used to simulate the bicontinuous medium, usually set to be 1000;

“Equivalent snow grain radius”: optical snow grain radius, in mm;

“B parameter”: a parameter related to the size distribution of snow particles, a large number (>20) means uniform distribution of grain radius, and small values means very broad size distribution;

“Snow density”: in g/cm^3;

“Photon number”: large values means better simulation accuracy, and more computation time;

“Snow depth”: in meter, in the model, photons traveling beyond thickness will be totally absorbed;

“Solar incident angle”: zenith angle in degree;

Diffuse source: if the incident light source is diffuse or not. If “YES” selected, the “Solar incident angle” will be disregarded;

Click on the “Run” button to start the model simulation. When the simulation completed, click on the “Results” to see the simulation results, as shown in Fig. 3.3.1.c. The X-axis is the wavelength, the Y-axis is the directional-hemispherical reflectance (plane albedo). Click on the file names to download the result files to your local computer.

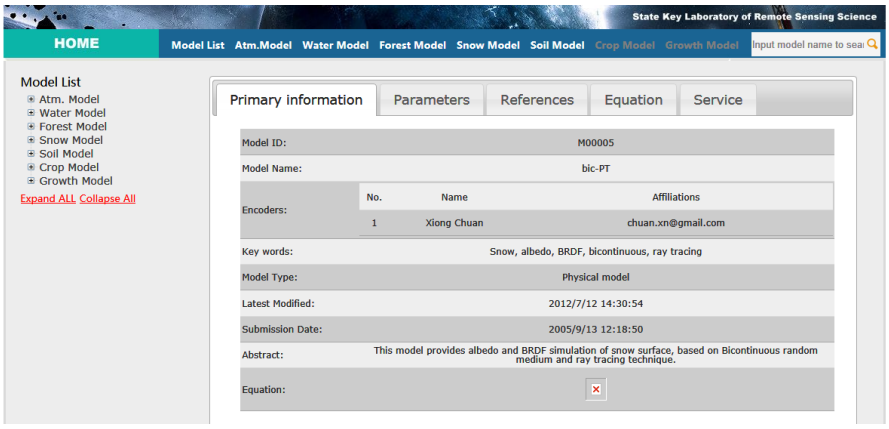


Fig. 3.3.1.a The GUI of the model service

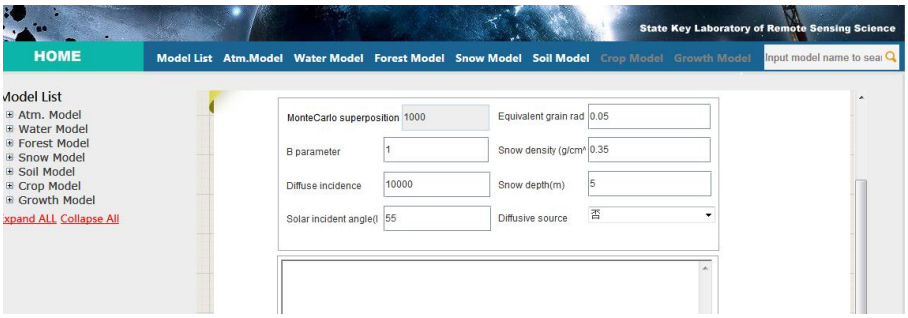


Fig. 3.3.1.b The input parameters

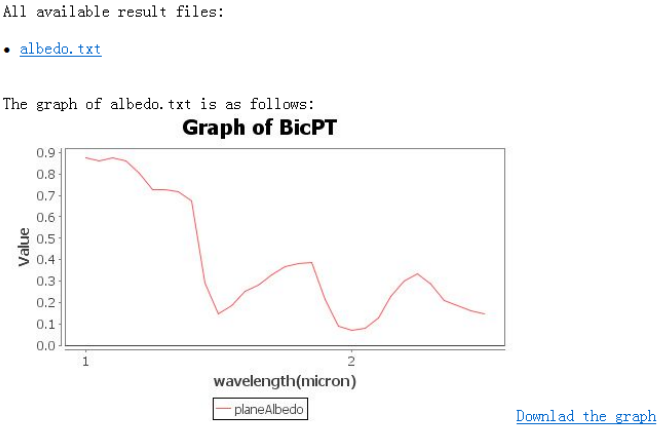


Fig. 3.3.1.c The model results

4. Soil

4.1 Microwave model

4.1.1 AIEM Model

(1) Introduction

Advanced Integral Equation Model (AIEM) was developed by Prof. Chen Kunshan based on Integral Equation Model(IEM)。AIEM is capable of accurately estimate radar bi-static scattering and has been widely used in remote sensing area. The copy right of the AIEM model belongs to Prof. Chen Kunshan. For any questions related to the web-based application, please contact: Dr. Du Jinyang，dujy@radi.ac.cn

Reference

Chen, Kun-Shan, et al. "Emission of rough surfaces calculated by the integral equation method with comparison to three-dimensional moment method simulations." Geoscience and Remote Sensing, IEEE Transactions on 41.1 (2003): 90-101.

(2) Usage

Graphic user interface (GUI) of this model is shown in Fig. 4.1.1, firstly click “Service” tab, then click “Run the service”. GUI of the model running is shown in Fig. 4.1.2. Click the “Run” button to start calculation.

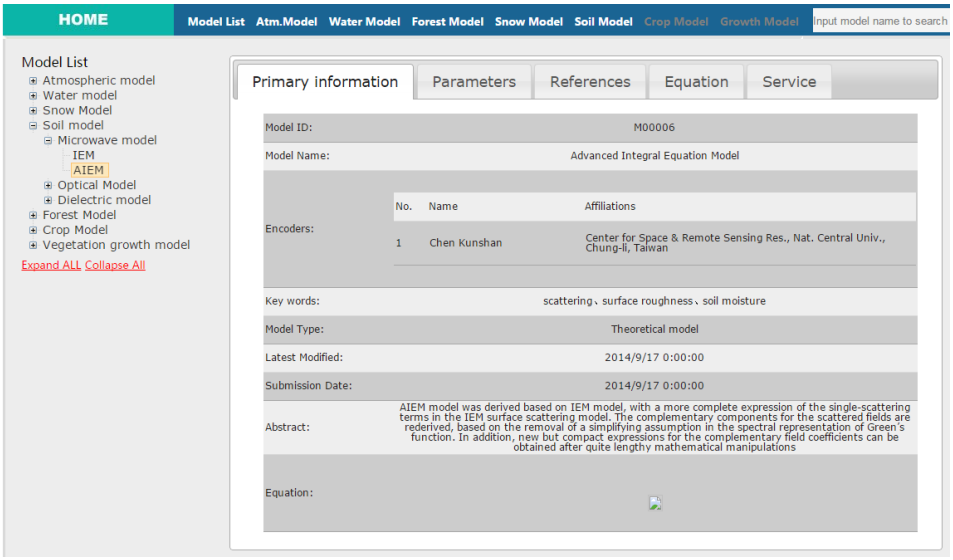

HOME
Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Input model name to search
Model List
Atmospheric model
Water model
Snow Model
Soil model
Microwave model
IEM
AIEM
Optical Model
Dielectric model
Forest Model
Crop Model
Vegetation growth model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00006
Model Name: Advanced Integral Equation Model
Encoders:
No. Name Affiliations
1 Chen Kunshan Center for Space & Remote Sensing Res., Nat. Central Univ., Chung-li, Taiwan
Key words: scattering、surface roughness、soil moisture
Model Type: Theoretical model
Latest Modified: 2014/9/17 0:00:00
Submission Date: 2014/9/17 0:00:00
Abstract: AIEM model was derived based on IEM model, with a more complete expression of the single-scattering terms in the IEM surface scattering model. The complementary components for the scattered fields are rederived, based on the removal of a simplifying assumption in the spectral representation of Green's function. In addition, new but compact expressions for the complementary field coefficients can be obtained after quite lengthy mathematical manipulations
Equation:

Fig.4.1.1 Main Interface

Model inputs are based on human-computer interactions. The input parameters are put by users based on the valid range defined by the program and indicated on the input interface. Specific input parameters include： (1)Frequency, valid range [0.1,18.7] GHz； (2) Incidence angle，valid range [5.0,60.0] degree；(3) RMS height，valid range [0.1,3.0] cm；(4) Correlation length，valid range [5.0,30.0] cm; (5) Volumetric soil moisture [0.03,0.5] m3/m3。Based on the inputs, VV and HH polarized backscattering coefficients are calculated by the AIEM model. An example of the application is shown in Fig.4.1.2 and also described below:

Input parameters：Frequency, 1.26 GHz；Incident angle，40 degree；RMSE height，1.0 cm；Correlation length，10.0 cm; Volumetric soil moisture, 0.3 m3/m3

Output：VV －13.08 dB， HH－16.85 dB

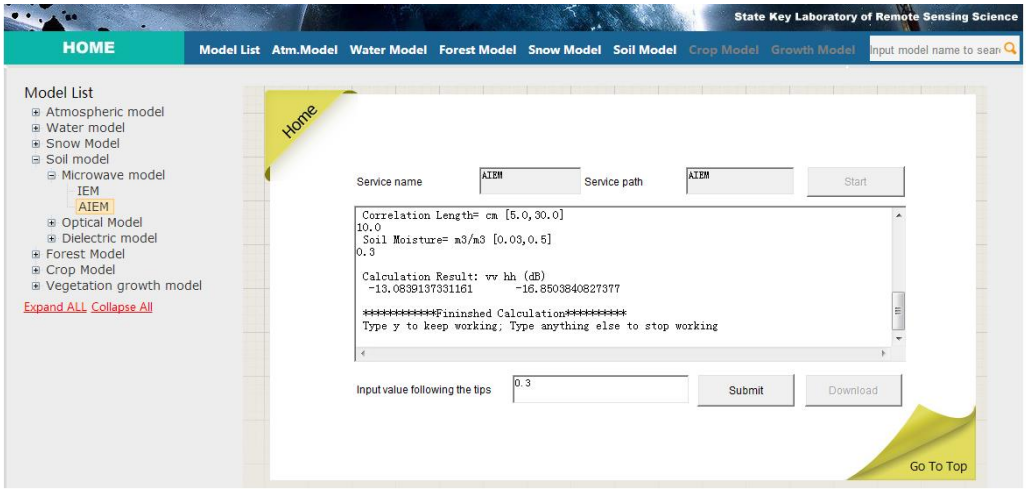


Fig.4.1.2 Operation Interface

4.2 Optical model

NULL

4.3 Dielectric constant model

4.3.1 Dobson model

（1）Brief Introduction

The Dobson model，as a semi-empirical model, developed a set of empirical polynomial expressions for the dielectric constant (ε) as a function of volumetric water content (m_v), clay (C) and sand contents (S) based on five soil types, a wide range of moisture conditions from 1.4 to 18GHz and extended to 0.3-1.3GHz in 1995.

References：

M.C. Dobson, F.T. Ulaby, M.T. Hallikainen, and M.A. Elrayes, Microwave Dielectric Behavior of Wet Soil .2. Dielectric Mixing Models. Ieee Transactions on Geoscience and Remote Sensing, 1985. 23(1): p. 35-46.

（2）Operation Instruction

The main interface is shown as Fig. 4.3.1-a, click on “Service” button, then click on “Run” button, shown in Fig. 4.3.1-b. Enter into the main interface of “Run Sevrice”. There will an intermediate result in tooltip.

“System echo —> The service Dobson has finished!” will be displayed in messesage box, shown as Fig. 4.3.1-c. At the same time the “Run” button turn into grey, then click on “Results” button will popup results interface, shown as Fig. 4.3.1-d. The simulated result contained in “Dobson.out” and the graph of Dobson is also shown.

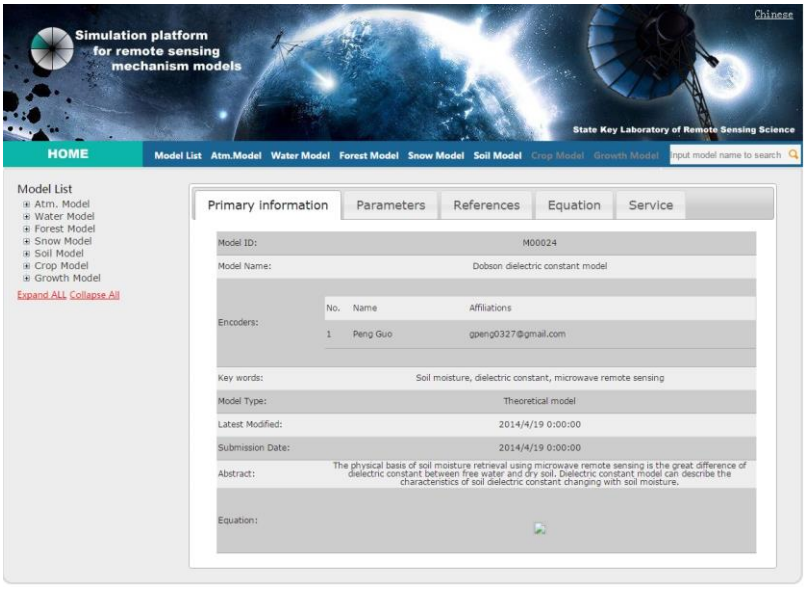


Fig. 4.3.1-a Main interface of Dobson Model

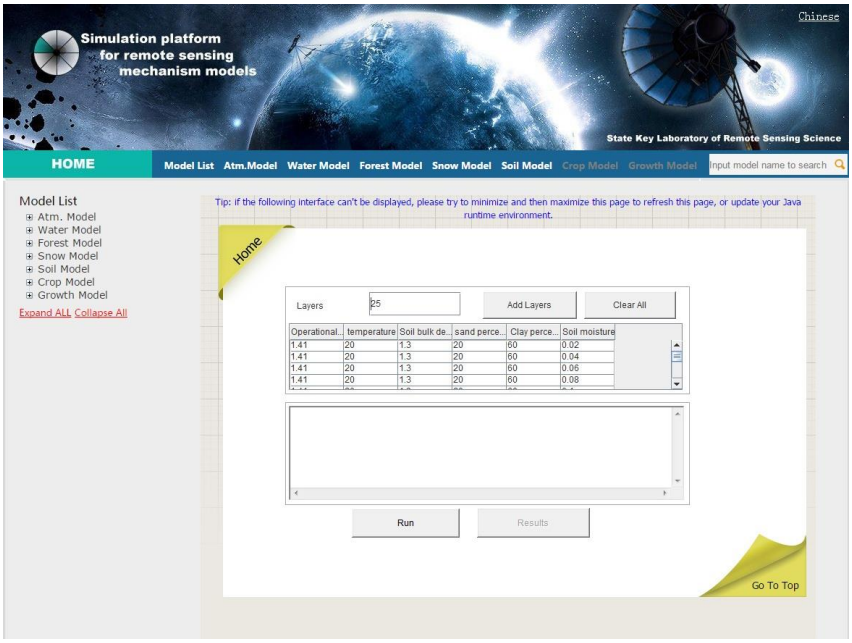
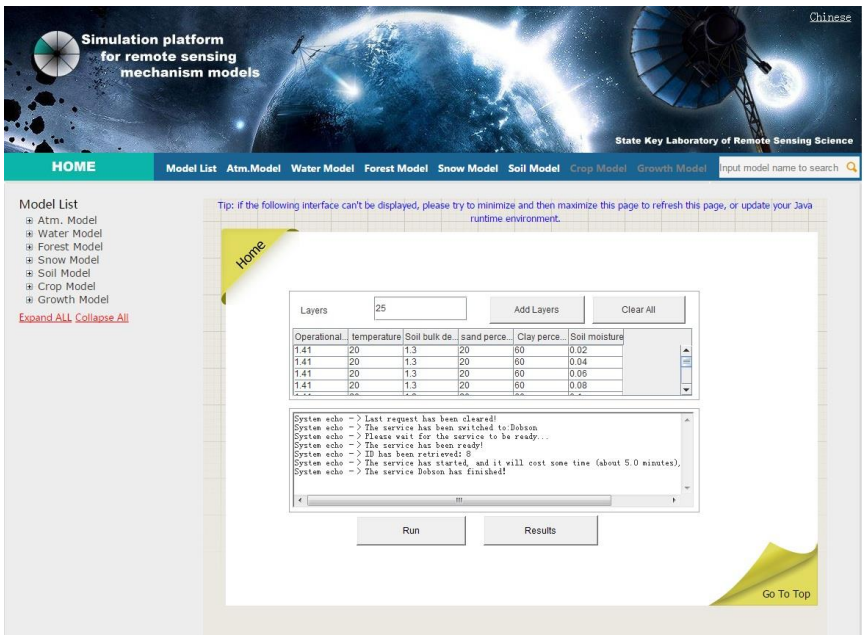


Fig. 4.3.1-b Main interface of Model Running


Simulation platform
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mechanism models
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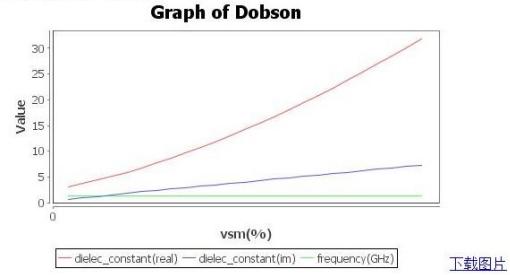
State Key Laboratory of Remote Sensing Science
HOME
Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Input model name to search
Model List
Atm. Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Expand ALL Collapse All
Tip: if the following interface can't be displayed, please try to minimize and then maximize this page to refresh this page, or update your Java runtime environment.
Home
Layers
25
Add Layers
Clear All
Operational..
temperature
Soil bulk de...
sand perce...
Clay perce...
Soil moisture
1.41 20 1.3 20 60 0.02
1.41 20 1.3 20 60 0.04
1.41 20 1.3 20 60 0.06
1.41 20 1.3 20 60 0.08
System echo -> Last request has been cleared!
System echo -> The service has been switched to:Dobson
System echo -> Please wait for the service to be ready...
System echo -> The service has been ready!
System echo -> ID has been retrieved: 8
System echo -> The service has started, and it will cost some time (about 5.0 minutes).
System echo -> The service Dobson has finished!
Run
Results
Go To Top

Fig.4.3.1-c Interface of Model running finished

所有结果文件下载：

- Dobson.out

Dobson.out的曲线图为：



下载图片

Fig.4.3.1-d Results of Model running

4.3.2 Mironov Model

（1）Brief introduction

The Mironov model is based on the refractive mixing dielectric model. It was developed from 15 soil types dielectric measurements, covering a wide range of moisture and frequency conditions at the temperature of 20 °. In contrast to the Dobson model, the Mironov model employs the spectra explicitly related to either bound soil water (BSW) or free soil water (FSW).

References：

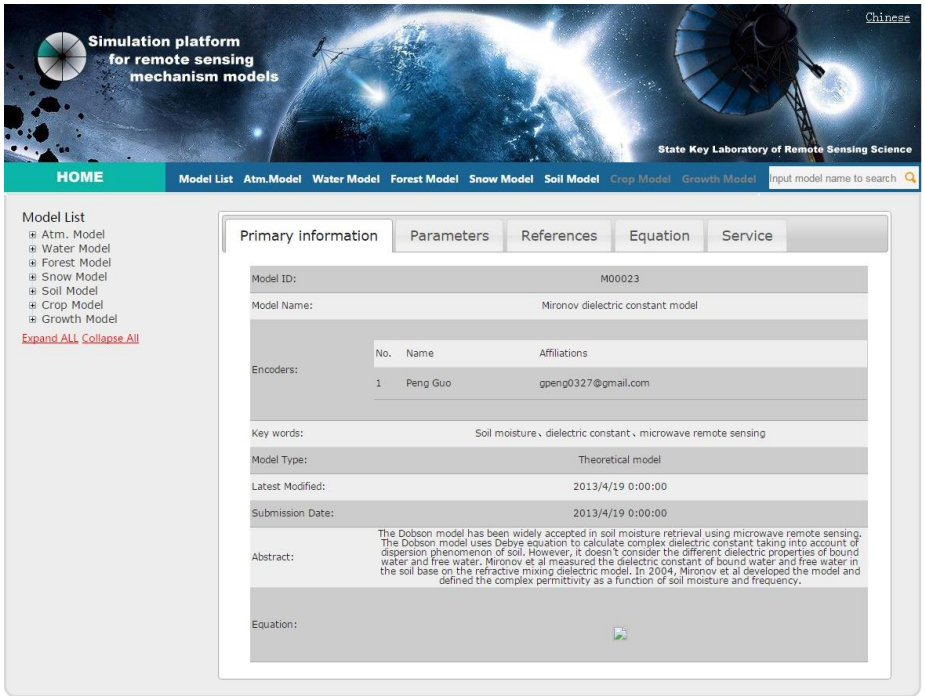
V.L. Mironov, M.C. Dobson, V.H. Kaupp, S.A. Komarov, and V.N. Kleshchenko, Generalized refractive mixing dielectric model for moist soils. Ieee Transactions on Geoscience and Remote Sensing, 2004. 42(4): p. 773-785.

V.L. Mironov, L.G. Kosolapova, and S.V. Fomin, Physically and Mineralogically Based Spectroscopic Dielectric Model for Moist Soils. Ieee Transactions on Geoscience and Remote Sensing, 2009. 47(7): p. 2059-2070.

（2）Operation instruction

The main interface is shown as Fig. 4.3.2-a, click on “Service” button, then click on “Run” button, shown in Fig. 4.3.2-b. Enter into the main interface of “Run Sevrice”. There will an intermediate result in tooltip.

“System echo —> The service Dobson has finished!” will be displayed in messesage box, shown as Fig. 4.3.2-c. At the same time the “Run” button turn into grey, then click on “Results” button will popup results interface, shown as Fig. 4.3.2-d. The simulated result contained in “Dobson.out” and the graph of Dobson is also shown.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Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
input model name to search
Model List
Atm. Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00023
Model Name: Mironov dielectric constant model
Encoders:
No. Name Affiliations
1 Peng Guo gpeng0327@gmail.com
Key words: Soil moisture、dielectric constant、microwave remote sensing
Model Type: Theoretical model
Latest Modified: 2013/4/19 0:00:00
Submission Date: 2013/4/19 0:00:00
Abstract: The Dobson model has been widely accepted in soil moisture retrieval using microwave remote sensing. The Dobson model uses Debye equation to calculate complex dielectric constant taking into account of dispersion phenomenon of soil. However, it doesn't consider the different dielectric properties of bound water and free water. Mironov et al measured the dielectric constant of bound water and free water in the soil base on the refractive mixing dielectric model. In 2004, Mironov et al developed the model and defined the complex permittivity as a function of soil moisture and frequency.
Equation:

Fig. 4.3.2-a Main interface of Dobson Model

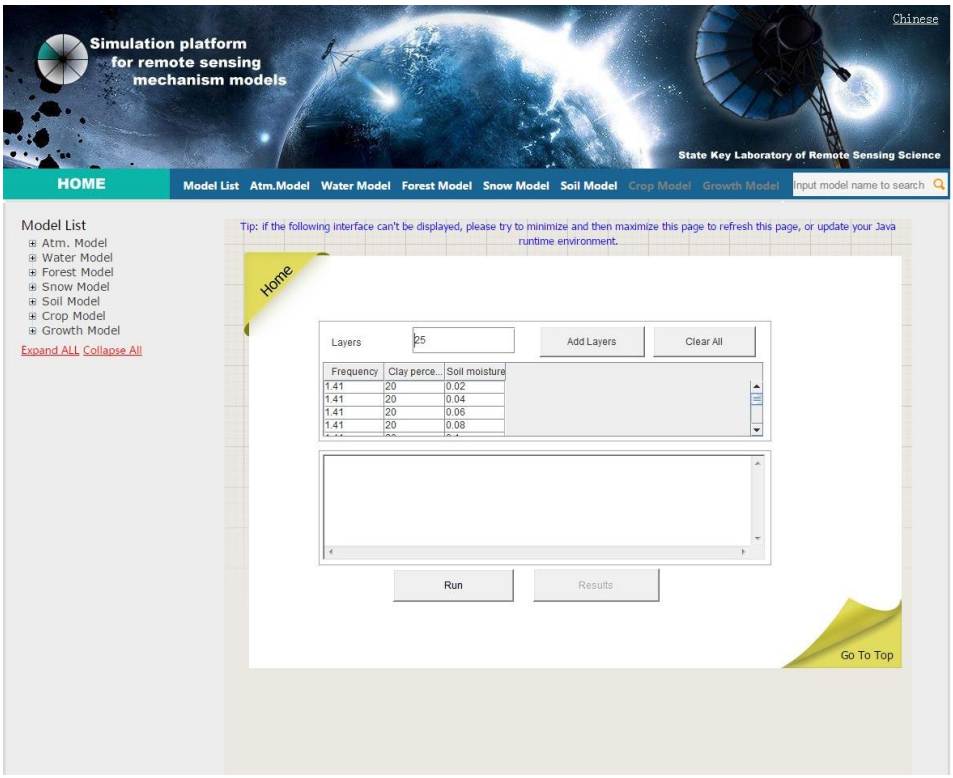


Fig. 4.3.2-b Main interface of Model Running

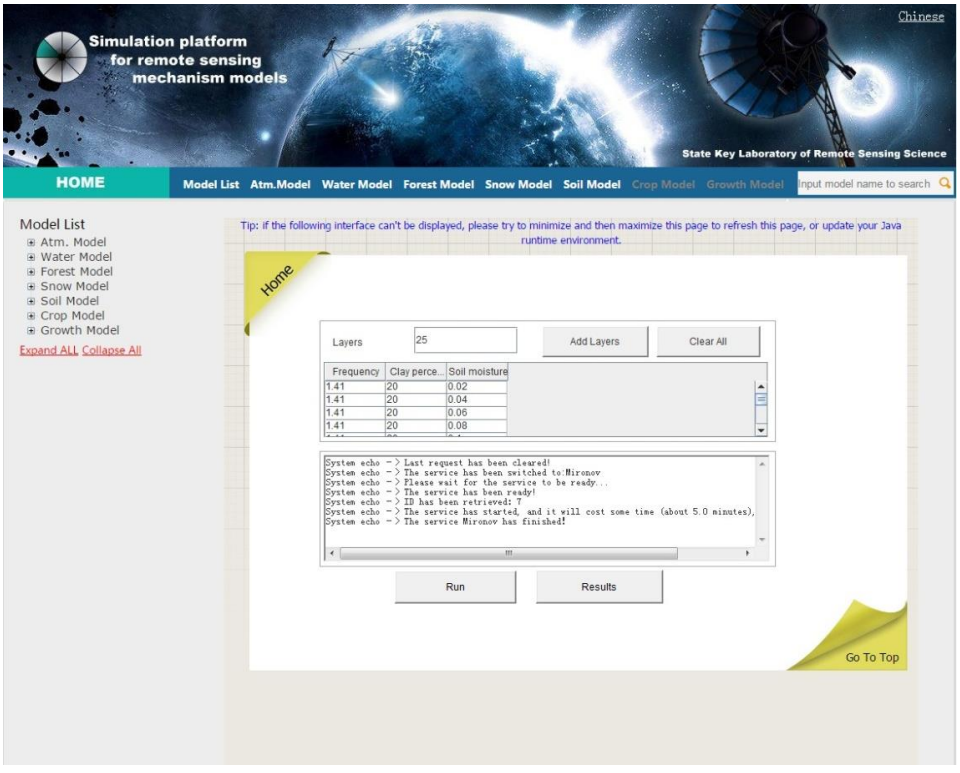


Fig.4.3.2-c Interface of Model running finished

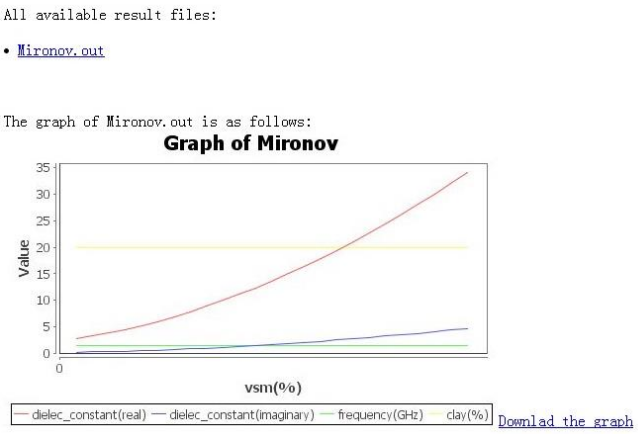


Fig.4.3.2-d Results of Model running

4.3.3 Frozen Dielectric Model

(1) Brief introduction

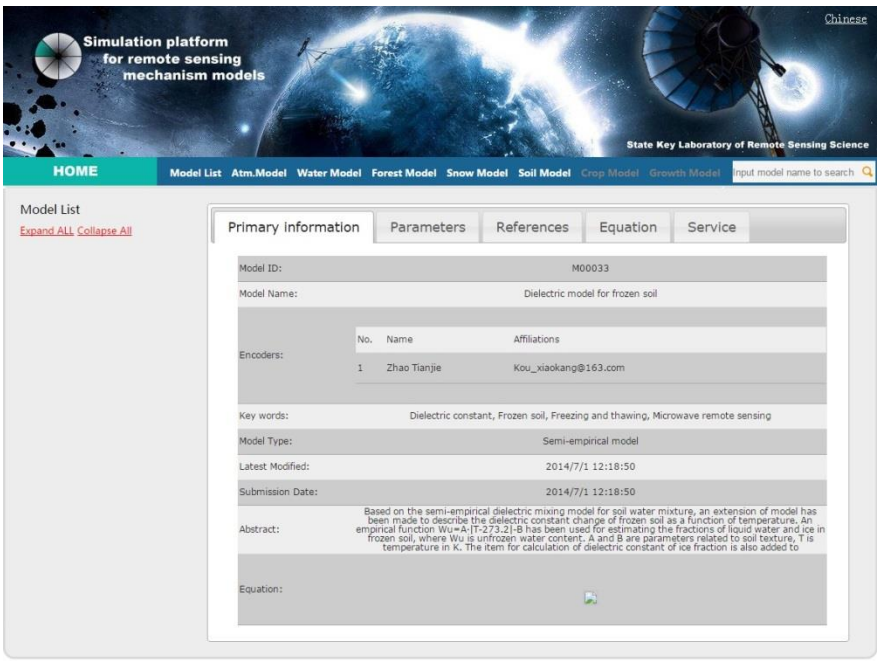
The frozen soil dielectric model is developed by Prof. Zhang from Beijing Normal University. It was based on the phenomenon that water in soil will freeze below 0℃ and made an improvement to Dobson model. Through the measurements, it can be found that with the decreasing of temperature, the permittivity of permafrost is mainly associated with immobile water content in soil. Since immobile water content is related with soil texture, in the model, the relationship between soil texture and immobile water content was developed based on the measurements. In addition, Debye equation was used to calculate the water permittivity. The copyright of the model was owned by Prof. Zhang. If there is a problem please contact: kou_xiaokang@163.com

Reference

Zhang L, Shi J, Zhang Z, et al. The estimation of dielectric constant of frozen soil-water mixture at microwave bands[C]//Geoscience and Remote Sensing Symposium, 2003. IGARSS'03. Proceedings. 2003 IEEE International. IEEE, 2003, 4: 2903-2905.

(2) Operation Instruction

The main interface of the model was shown in Figure 4.3.3-a, Click the “Service” button，and then clicking the “run model” button, the running interface of the model appeared as shown in Figure 4.3.3-b. The layers in the mail interface represent the number of the data, including six parameters (as fre, Sandc, Clayc, Bd, ts and vms). The meaning of each parameter was explained in the next part. Each parameter could be input based on the requirements. Click the “Run” button, the calculation interface appeared, as shown in Figure 4.3.3-c. The message “the service frozen dielectric has finished” will be displayed at the end of the program. Click the “Results” button, the results will be shown in Figure 4.3.3-d. It shows the relationship between soil permittivity and temperature.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Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
input model name to search
Model List
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID:
M00033
Model Name:
Dielectric model for frozen soil
Encoders:
No.
Name
Affiliations
1
Zhao Tianjie
Kou_xiaokang@163.com
Key words:
Dielectric constant, Frozen soil, Freezing and thawing, Microwave remote sensing
Model Type:
Semi-empirical model
Latest Modified:
2014/7/1 12:18:50
Submission Date:
2014/7/1 12:18:50
Abstract:
Based on the semi-empirical dielectric mixing model for soil water mixture, an extension of model has been made to describe the dielectric constant change of frozen soil as a function of temperature. An empirical function Wu=A·|T-273.2|-B has been used for estimating the fractions of liquid water and ice in frozen soil, where Wu is unfrozen water content. A and B are parameters related to soil texture, T is temperature in K. The item for calculation of dielectric constant of ice fraction is also added to
Equation:

Figure 4.3.3-a Main interface of the model

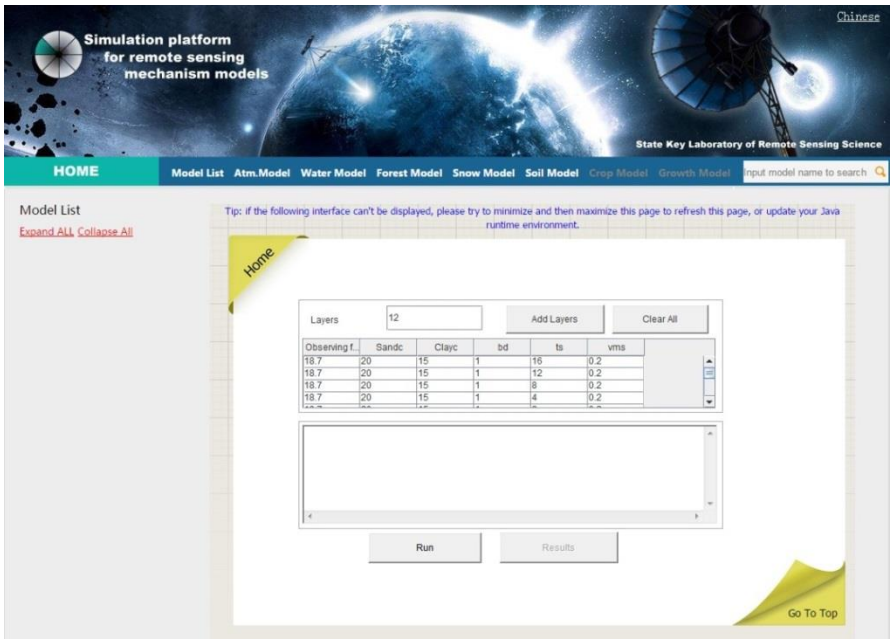
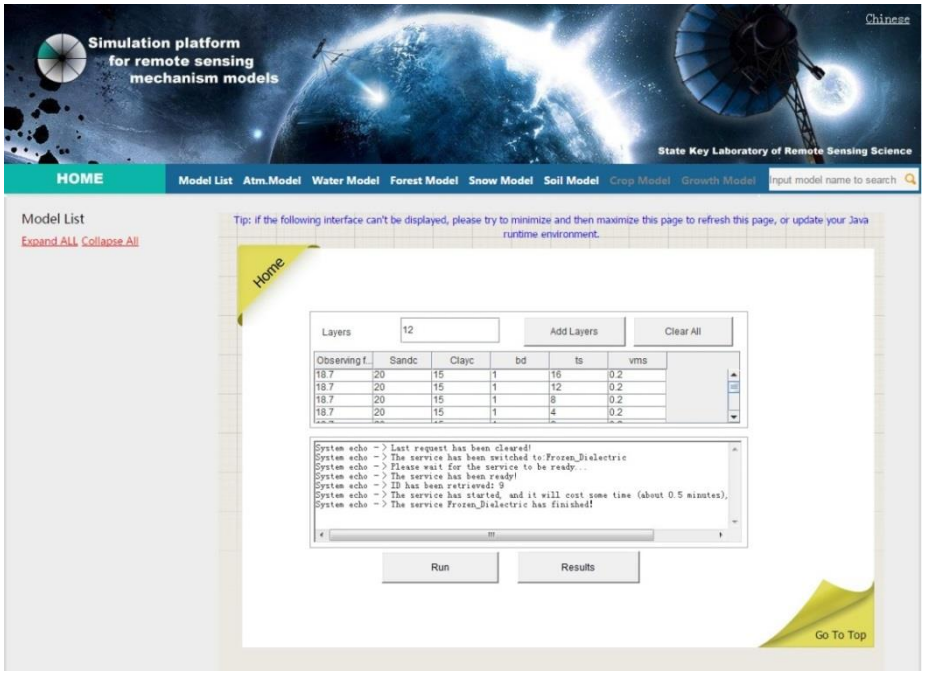


Figure 4.3.3-b running interface of the model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mechanism models
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Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Input model name to search
Model List
Expand ALL Collapse All
Tip: if the following interface can't be displayed, please try to minimize and then maximize this page to refresh this page, or update your Java runtime environment.
Home
Layers
12
Add Layers
Clear All
Observing f...
Sandc
Clayc
bd
ts
vms
18.7 20 15 1 16 0.2
18.7 20 15 1 12 0.2
18.7 20 15 1 8 0.2
18.7 20 15 1 4 0.2
System echo -> Last request has been cleared!
System echo -> The service has been switched to:Frozen_Dielectric
System echo -> Please wait for the service to be ready...
System echo -> The service has been ready!
System echo -> ID has been retrieved: 9
System echo -> The service has started, and it will cost some time (about 0.5 minutes).
System echo -> The service Frozen_Dielectric has finished!
Run
Results
Go To Top

Figure 4.3.3-c Calculation interface

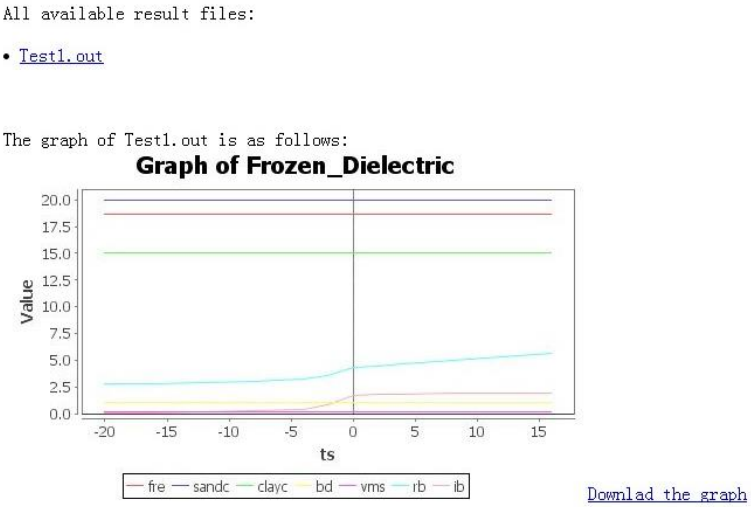


Figure 4.3.3-d Results interface

(3) Parameters

fre：Frequency, 0~100GHz

Sandc：Sand content of soil, 0-100（%）

Clayc：Clay content of soil, 0-100（%）

Bd：Per unit volume of soil with the weight of dry soil, 0.8-1.6（F/cm3）

ts：Environment temperature, <0℃

vms：The weight of per unit volume of soil water, 0-0.6

5. Forest

5.1 Passive microwave model

(1) Introduction

Matrix-Doubling (MD) algorithm is developed based on the ray-tracing technique, which accounts for multiple scattering inside the vegetation layer and that between vegetation and soil surface. The vegetation is treated as a collection of randomly distributed discrete scatterers. The scatterers are modeled as disks (leaves) and cylinders (branches) of different sizes. The General Rayleigh-Gans Approximation (GRG) or Physical Optical (PO) approximation model and Infinite Length Cylinder (IL) approximation are adopted to simulate the scattering of the scatterers. The AIEM model is adopted to simulate the surface emissivity.

To calculate the emissivity with this model, the forest is divided into three components, e.g. the canopy, the trunk and the ground, where the canopy is modeled as randomly distributed discs, and the trunk as vertically cylinders.

In each sub-layer, the incident and scattering angles are divided into many small intervals to account for as many directions as possible. For each incident angle, the scattering matrix S and transmission matrix T at the nearby sub-layer $\Delta z1$ and $\Delta z2$ with equal thickness can be obtained by the radiative transfer solution.

Since it takes volume scattering into account, it can better describe the scattering mechanism within the vegetation and thus can be used at higher frequency or for denser vegetation. Any questions contact: Linna Chai chai@bnu.edu.cn

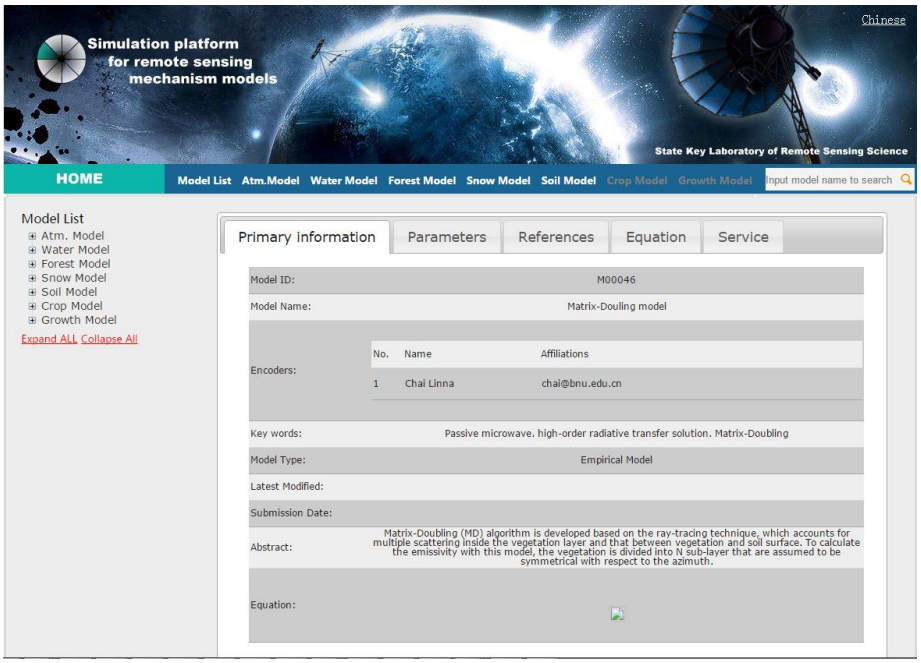
Reference

1. Passive Microwave Remote Sensing of Forests: A Model Investigation, Paolo Ferrazzoli, IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, 1996.
2. Electromagnetic wave scattering from some vegetation samples. M.A. Karam, A.K. Fung, et.al., IEEE TGARS, Vol.26, No.6,pp.799-808,1988
3. Scattering from arbitrarily oriented dielectric disks in the physical optics regime, ,D.M. LeVine, Meneghini, H. Lang, S.Seker, Journal of Optical Society of America, vol.73, 1255-1262, 1983.
4. Electromagnetic scattering from a layer of finite-length, randomly oriented dielectric circular cylinders over a rough interface with application to vegetation", Karam, M. A. and A. K. Fung, Int. J. of Remote Sensing,Vol.9, No.6, 1109–1134, 1988
5. Emission of Rough Surfaces Calculated by the Integral Equation Method With Comparison to Three-Dimensional Moment Method Simulations, Chen.K.S, Wu.T.D, Tsang L,IEEE Trans Geosci Remote Sensing, 2003, 35:731-749'

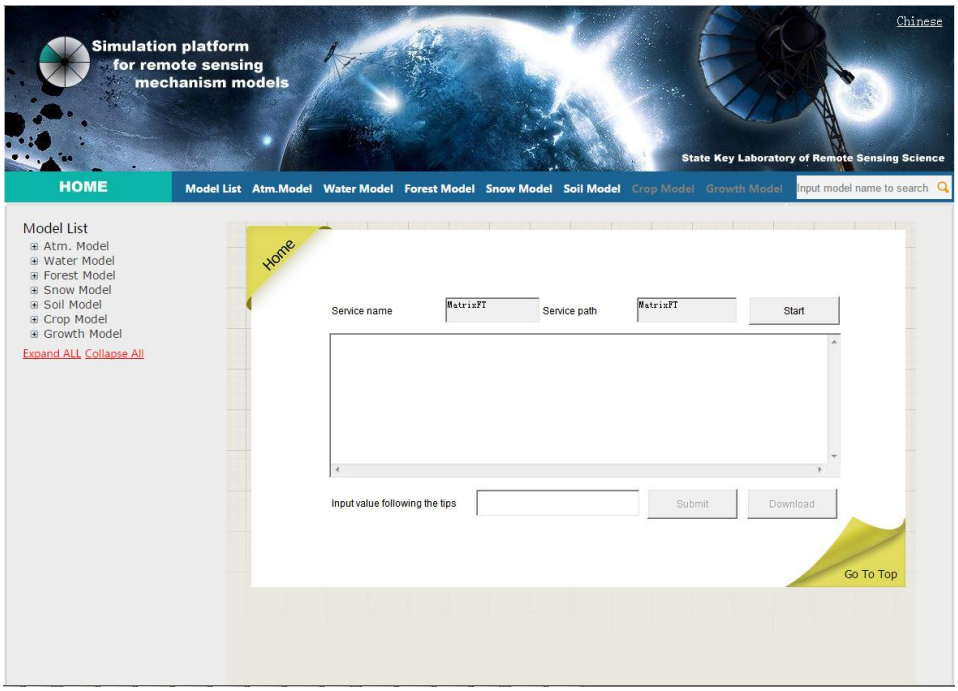
(2) Instruction

The model home page is shown as fig. 5.1-a. Click “Service”->“Run the service” button, then you enter the model running interface, as shown in fig. 5.1-b.Click “start” button, the model will be running. You can input the parameters according to the tips shown on the interface. After each input, you should click “submit” to do the next, like fig. 5.1-c.

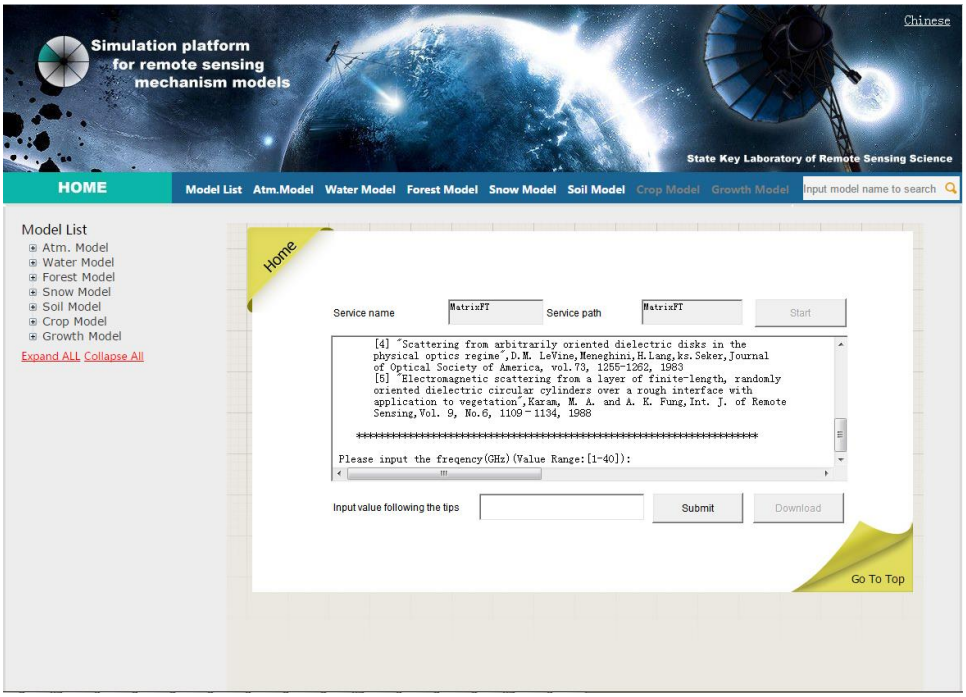
As the model ends running, the dialog box will show “system echo->the service MatrixFT has finished”. And the button “submit” is disabled. You can check the result in the page, e.g. the emissivity of H and V polarization from 2.5 ° to 87.5 °. Also you can click “Download” button to download the result as text and graph.



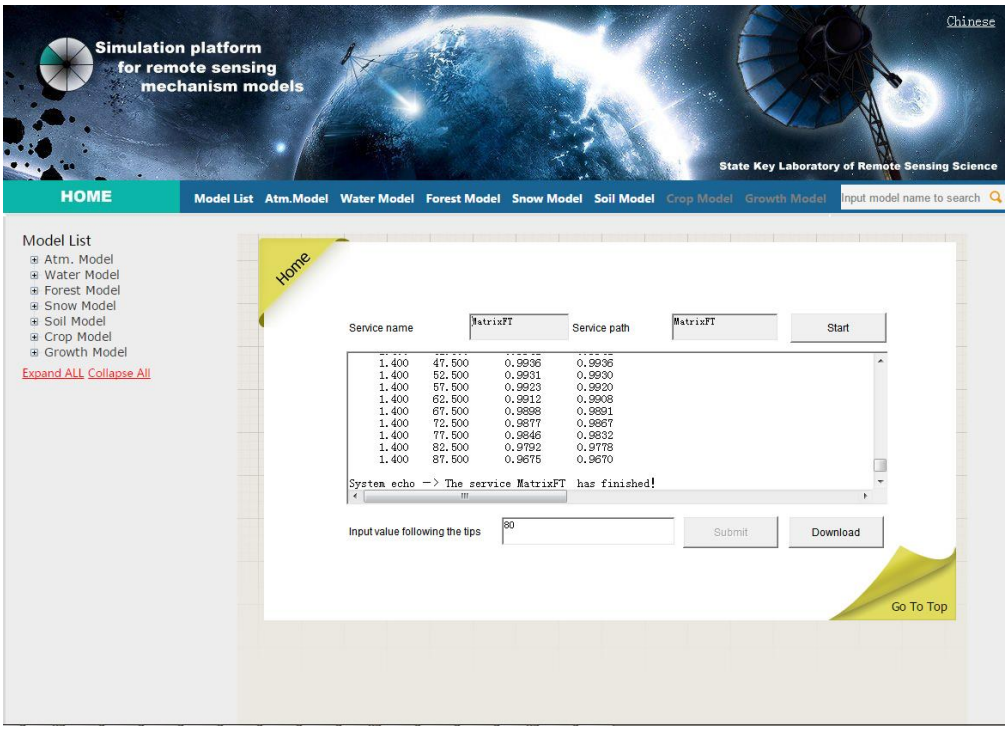
5.1-a Model home page



5.1-b Model running interface



5.1-c Parameter input interface



5.1-d Result interface

(3) Instruction of parameters

Please input the freqency(GHz):6.925 % simulated emitted frequency

Please input the soil parameters:

volume moisture(%):30 % soil moisture

standard deviation(m):0.02 % Soil roughness standard deviation

surface correlation length(m):0.1 % Soil roughness correlation length

Please input the vegetation parameters:

canopy depth(m):0.19	% Canopy depth, excluding stalk
leaf radius(m):0.0267	% Statistically average radius of round leaf
leaf thickness(m):0.00023	% Statistically average thickness of round leaf
leaf number(m-3):316	% Statistically average leaf number per unit
leaf moisture(%):82.2	% Statistically average leaf moisture
branch radius(m):0.0009	% Statistically average branch cross-section radius radius
branch height(m):0.05	% Statistically average branch height
branch number(m-3):285	% Statistically average branch number per unit
branch moisture(%):88.1	% Statistically averagebranch moisture
trunk radius(m):0.03	% Statistically average trunk cross-section radius radius
trunk height(m):2.0	% Statistically average trunk height
trunk number(m-3):0.8	% Statistically average trunk number per unit
trunk moisture(%):65	% Statistically averageTrunk moisture

5.2 Active microwave model

5.2.1 3D Radar Backscatter Model of Forest Canopies

(1)Introduction

The model was developed by Professor Guoqing Sun at University of Maryland and Professor Kenneth Jon Ranson at NASA Goddard Space flight Center and was further improved by Wenjian Ni at institute of remote sensing applications CAS. Matrix-doubling method was used in the improved model to consider the multiple-scattering within forest canopies. The model was developed based on 3D Forest scene described by cubic cells. Therefore，both the horizontal and vertical heterogeneities could be accounted for. The scattering components considered in this study include direct backscattering from forest canopy, direct backscattering from ground, direct backscattering from trunks, double scattering between forest canopy and ground, double scattering between trunks and ground. The copyrights of the model belongs to Professor Guoqing Sun and Professor Kenneth Jon Ranson. Please contact with Wenjian Ni (niwj@radi.ac.cn) if you have any questions.

Reference

Sun, G.Q. and K.J. Ranson, A 3-Dimensional Radar Backscatter Model of Forest Canopies. IEEE Transactions on Geoscience and Remote Sensing, 1995. 33(2): p. 372-382.

Ni, W.J., Z.F. Guo, and G.Q. Sun, Improvement of a 3D radar backscattering model using matrix-doubling method. Science China-Earth Sciences, 2010. 53(7): p. 1029-1035.

(2) Guide

The main interface of the model is shown as Fig.5.2.1-a. The model could be launched by left click on the card “Service” and then left click on the item “Run the service”. The running interface of radar backscatter model is shown as Fig.5.2.1-b. The interpretation of parameters used to derive the model will appear by click on “View Example File” as shown in Fig.5.2.1-c. Parameters used to derive the model without any interpretations will be given by further click on “example file”. It can be copied into

as text file named as “in_para.txt”. Go back to the running interface of the model and click on “upload file”, the interface of uploading driven file will appear as Fig. 5.2.1-d. Browse to the file “in_para.txt” and “Upload” it. Go back to the running interface and run the model by clicking on “start”. The model will run several minute according to the size of forest scene set in the file “in_para.txt”. The item “start” will change to inactive and “Results” will change to active when the running is completed. Then click on “Results” the web page containing the file “backscattering.txt” will appear. Click on “backscattering.txt” will see its content:

tot: HH,HV VV
 0.289212 0.049860 0.182883
cvs:
 0.102393 0.021793 0.092893
mcg:
 0.156528 0.027074 0.069168
sbs:
 0.015354 0.000986 0.013949
dtg:
 0.015004 0.000000 0.006882
dtgd:
 0.000009 0.000000 0.000015

Where tot：total backscattering，cvs：canopy vegetation scattering、mcg：multiple scattering between canopy and ground;、sbs：single backscattering from soil、dtg：double bounce between trunks and ground、dtgd：direct backscattering from trunks；They are linear value of backscattering coefficients of HH,HV and VV from left to right under each line.

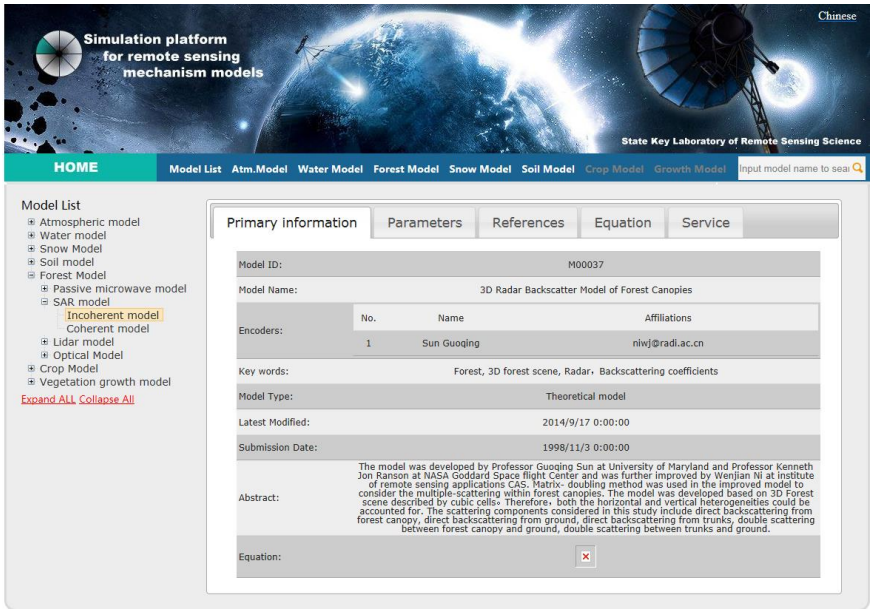

Simulation platform for remote sensing mechanism models
Chinese
State Key Laboratory of Remote Sensing Science
HOME
Model List
Atm.Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Model List
Atmospheric model
Water model
Snow Model
Soil model
Forest Model
Passive microwave model
SAR model
Incoherent model
Coherent model
Lidar model
Optical Model
Crop Model
Vegetation growth model
Expand ALL Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00037
Model Name: 3D Radar Backscatter Model of Forest Canopies
Encoders: No. Name Affiliations
1 Sun Guoqing niwj@radi.ac.cn
Key words: Forest, 3D forest scene, Radar, Backscattering coefficients
Model Type: Theoretical model
Latest Modified: 2014/9/17 0:00:00
Submission Date: 1998/11/3 0:00:00
Abstract: The model was developed by Professor Guoqing Sun at University of Maryland and Professor Kenneth Jon Ranson at NASA Goddard Space flight Center and was further improved by Wenjian Ni at institute of remote sensing applications CAS. Matrix- doubling method was used in the improved model to consider the multiple-scattering within forest canopies. The model was developed based on 3D Forest scene described by cubic cells. Therefore, both the horizontal and vertical heterogeneities could be accounted for. The scattering components considered in this study include direct backscattering from forest canopy, direct backscattering from ground, direct backscattering from trunks, double scattering between forest canopy and ground, double scattering between trunks and ground.
Equation:

Fig5.2.1-a Main interface of Radar Backscatter Model

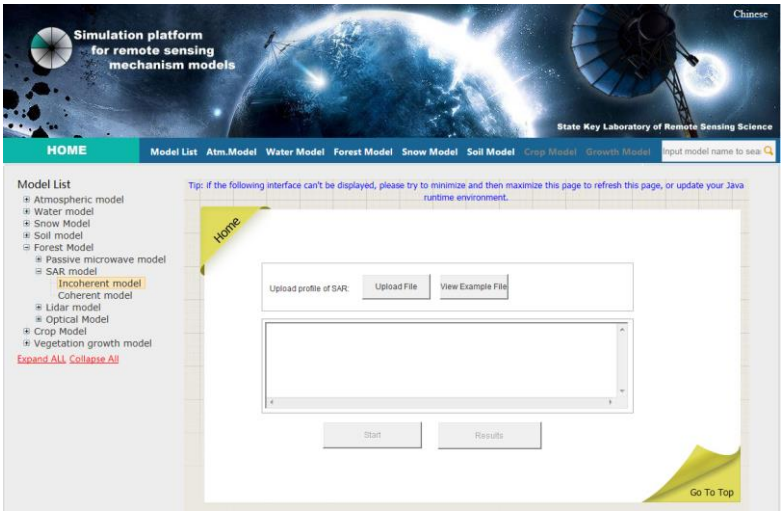


Fig5.2.1-b The running interface of Radar Backscatter Model

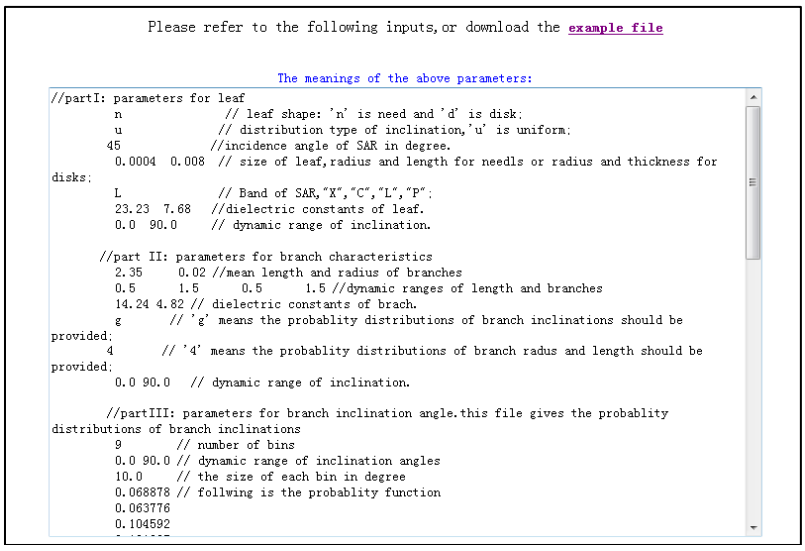

Please refer to the following inputs, or download the example file
The meanings of the above parameters:
//partI: parameters for leaf
n // leaf shape: 'n' is need and 'd' is disk;
u // distribution type of inclination,'u' is uniform;
45 //incidence angle of SAR in degree.
0.0004 0.008 // size of leaf,radius and length for needls or radius and thickness for disks;
L // Band of SAR,"X","C","L","P";
23.23 7.68 //dielectric constants of leaf.
0.0 90.0 // dynamic range of inclination.
//part II: parameters for branch characteristics
2.35 0.02 //mean length and radius of branches
0.5 1.5 0.5 1.5 //dynamic ranges of length and branches
14.24 4.82 // dielectric constants of brach.
g // 'g' means the probablity distributions of branch inclinations should be provided;
4 // '4' means the probablity distributions of branch radus and length should be provided;
0.0 90.0 // dynamic range of inclination.
//partIII: parameters for branch inclination angle.this file gives the probablity distributions of branch inclinations
9 // number of bins
0.0 90.0 // dynamic range of inclination angles
10.0 // the size of each bin in degree
0.068878 // follwing is the probablity function
0.063776
0.104592

Fig5.2.1-c Interpretation of parameters used to derive the model

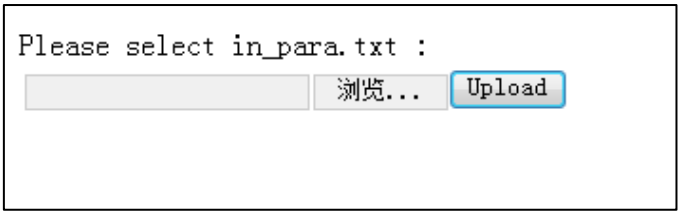


Fig5.2.1-d Interface of uploading driven file

(3) Interpretations of parameters in the file in_para.txt.

//partI: parameters for leaf

n // leaf shape: 'n' is need and 'd' is disk;

u // distribution type of inclination,'u' is uniform;

45 //incidence angle of SAR in degree, dynamic range [10-60] .

0.0004 0.008 // size of leaf,radius and length for needls or radius and thickness for disks;

```
L                       // Band of SAR,"X","C","L","P";
23.23   7.68    //dielectric constants of leaf.
0.0   90.0        // dynamic range of inclination.
//part II: parameters for branch characteristics
2.35   0.02      //mean length and radius of branches (in meter)
0.5    1.5    0.5    1.5 //dynamic ranges of length and branches
14.24 4.82   // dielectric constants of brach.
g           // 'g' means the probablity distributions of branch inclinations should be provided;
4           // '4' means the probablity distributions of branch radus and length should be provided;
0.0 90.0    // dynamic range of inclination.
//partIII: parameters for branch inclination angle.this file gives the probablity distributions of branch inclinations
9             // number of bins
0.0 90.0 // dynamic range of inclination angles
10.0        // the size of each bin in degree
0.068878 // follwing is the probablity function，summary of the should be 1.0
0.063776
0.104592
0.191327
0.165816
0.091837
0.117347
0.081633
0.114796
//part IV: parameters for branch size:this file gives the probablity distributions of branch size
8    // number of bins
0.003598        0.257859    0.55102   // radius, length and probablity function，summary of the third column should be 1.0
0.007915        0.881859    0.244898
0.009321        1.51722     0.114796
0.010724        2.13853     0.030612
0.011431        2.63398     0.015306
0.017403        3.44463     0.02551
0.022373        3.76765         0.010204
0.023544        4.54231         0.007653
//part V: parameters for forest stand,
0.5 0.5 // the cell size used in the building of 3D forest scene
1           // number of tree species
71.43 -0.07 0.2219 -0.16 0.432 1.48 0.0//regression coefficients for calculating height from DBH - all zero means they were given
                                        in tree lists and do not need to calculate
180000.0 28.0 //number of leaves and branches per cumbic meters;
14.82 4.84    // dielectric constants of trunks
0.08172         // the minimum tree DBH
0 0             //slope and azimuth of terrain，
0               //ground surface types,'0' means uniform ground surface for all ground cells
9.6 2.04        // dielectric constants of ground surface
```

```
0.025 0.18      //ground roughness given by RMS height and correlation length
2               //'2'means ground scattering is calculated by IEM model
0               //'0' means one dimensional IEM model
1               //'1' means Gaussion distribution is used in IEM model
// part VI:the position and size of each tree, this is the list of trees used to build the 3D forest scene
300.000000  300.000000 60.000000 //width of forest stand(maximum X); length of forest stand(maximum Y);highest tree; all in meter
0.000000  0.000000      // begining of forest stands. always set as 0;
100.000000  200.000000  100.000000  200.000000 // the minimum and maximum X of ROI; the minimum and maximum Y of ROI;
2.210835  96.938843  14.100000  8.200000  5.800000  3.250000  1  1 //This is tree lists. One line for each tree. x； y； dbh(cm)；
                topH(m); Crown_Length;Crown_radius;species;crown shape code,0 for elipsoid and 1 for cone.
```

5.3. LiDAR

(1) Introduction

The model was developed in 2000 by Professor Guoqing Sun at University of Maryland and Professor Kenneth Jon Ranson at NASA Goddard Space flight Center. It was mainly used to simulate the LiDAR waveforms from forest scene described by cubic cells. The copyrights of the model belongs to Professor Guoqing Sun and Professor Kenneth Jon Ranson. Please contact with Wenjian Ni (niwj@radi.ac.cn) if you have any questions.

Reference：

Sun, G.Q. and K.J. Ranson, Modeling lidar returns from forest canopies. IEEE Transactions on Geoscience and Remote Sensing, 2000. 38(6): p. 2617-2626.

(2) Guide

The main interface of the model is shown as Fig.5.3-a. The model could be launched by left click on the card “Service” and then left click on the item “Run the service”. The running interface of radar backscatter model is shown as Fig.5.3-b. The interpretation of parameters used to derive the model will appear by click on “View Example File” as shown in Fig.5.3-c. Parameters used to derive the model without any interpretations will be given by further click on “example file”. It can be copied into as text file named as “in_para_lidar.txt”. Go back to the running interface of the model and click on “upload file”, the interface of uploading driven file will appear as Fig. 5.3-d. Browse to the file “in_para.txt” and “Upload” it. Go back to the running interface and run the model by clicking on “start”. The model will run several minute according to the size of forest scene set in the file “in_para_lidar.txt”. The item “start” will change to inactive and “Results” will change to active when the running is completed. Then click on “Results” the web page will appear as Fig. 5.3-e . “Results.txt” gives LiDAR waveform in text format while “out.para” gives parameters of forest structure over LiDAR footprint.

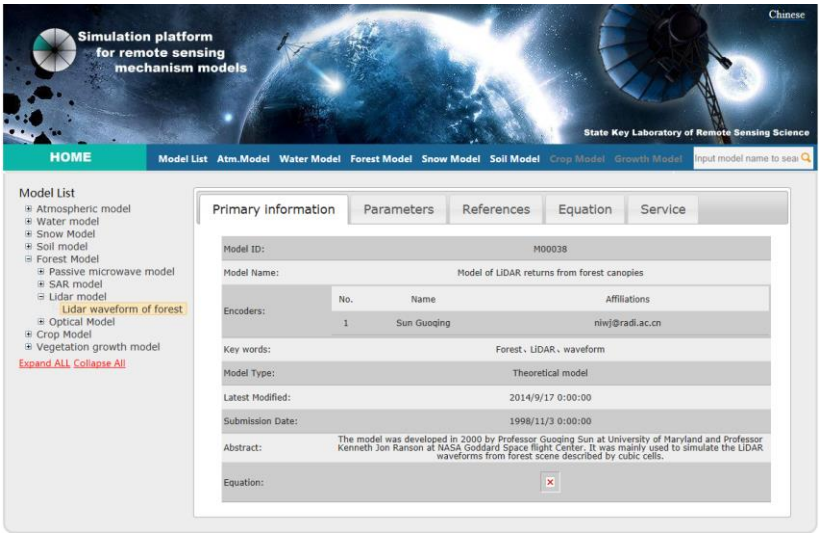


Fig5.3-a Main interface of LiDAR Model

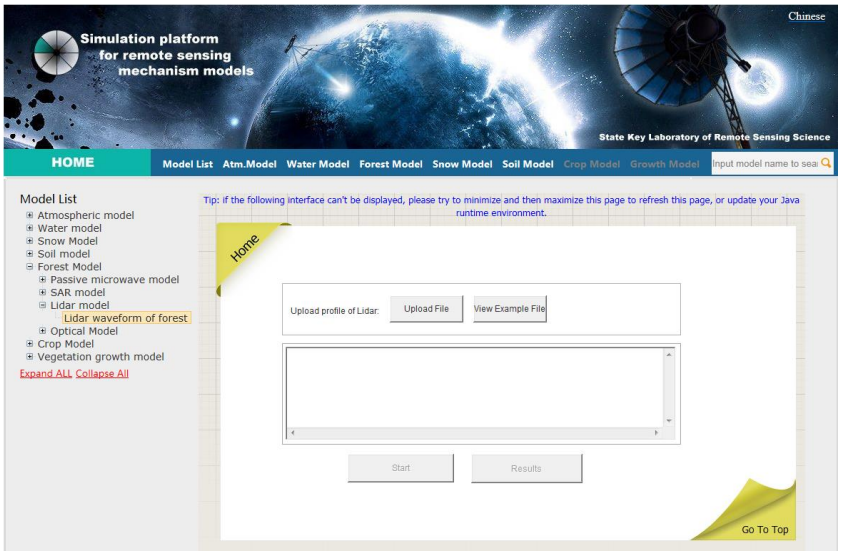


Fig5.3-b The running interface of LiDAR Model

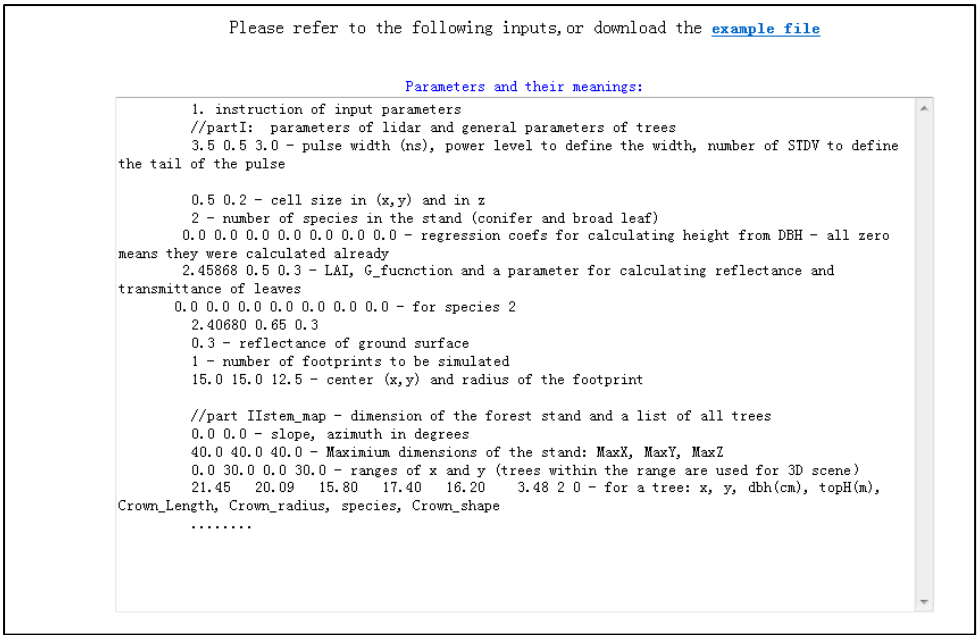

Please refer to the following inputs, or download the example file
Parameters and their meanings:
1. instruction of input parameters
//partI: parameters of lidar and general parameters of trees
3.5 0.5 3.0 - pulse width (ns), power level to define the width, number of STDV to define the tail of the pulse
0.5 0.2 - cell size in (x,y) and in z
2 - number of species in the stand (conifer and broad leaf)
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 - regression coefs for calculating height from DBH - all zero means they were calculated already
2.45868 0.5 0.3 - LAI, G_fucnction and a parameter for calculating reflectance and transmittance of leaves
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 - for species 2
2.40680 0.65 0.3
0.3 - reflectance of ground surface
1 - number of footprints to be simulated
15.0 15.0 12.5 - center (x,y) and radius of the footprint
//part IIstem_map - dimension of the forest stand and a list of all trees
0.0 0.0 - slope, azimuth in degrees
40.0 40.0 40.0 - Maximium dimensions of the stand: MaxX, MaxY, MaxZ
0.0 30.0 0.0 30.0 - ranges of x and y (trees within the range are used for 3D scene)
21.45 20.09 15.80 17.40 16.20 3.48 2 0 - for a tree: x, y, dbh(cm), topH(m), Crown_Length, Crown_radius, species, Crown_shape
.....

Fig5.3-c Interpretation of parameters used to derive the model

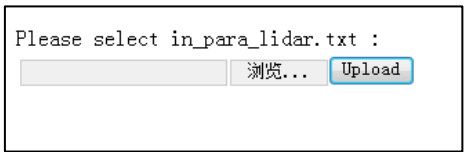


Fig5.3-d Interface of uploading driven file

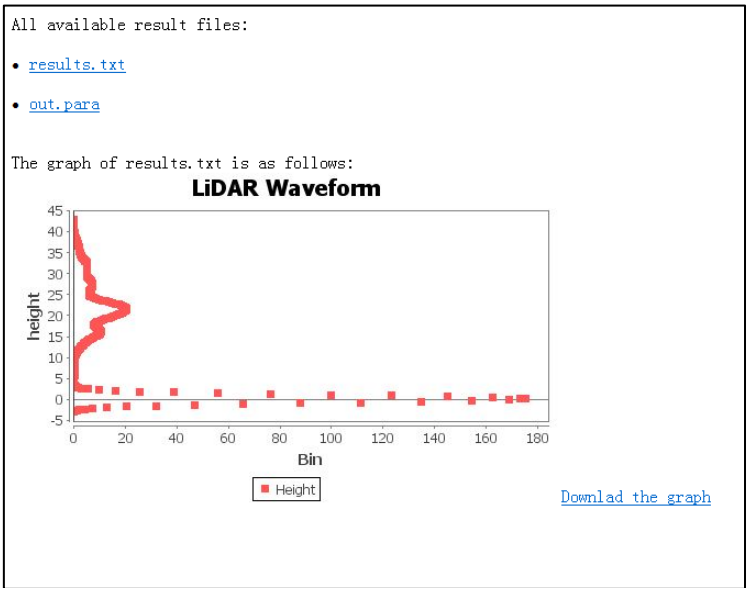


Fig5.3-e The results of LiDAR model

(3) Interpretations of parameters in the file in_para_lidar.txt

//partI: parameters of lidar and general parameters of trees

3.5 0.5 3.0 //pulse width (ns), power level to define the width, number of STDV to define the tail of the pulse

0.5 0.2 //cell size in (x,y) and in z，value range 0.1-1

2 - number of species in the stand (conifer and broad leaf)，value range 1-10；

0.0 0.0 0.0 0.0 0.0 0.0 0.0 - regression coefs for calculating height from DBH - all zero means they were calculated already

2.45868 0.5 0.3 //LAI, G_fucnction and a parameter for calculating reflectance and transmittance of leaves

0.0 0.0 0.0 0.0 0.0 0.0 0.0 //for species 2nd

2.40680 0.65 0.3

0.3 //reflectance of ground surface， value range 0-1；

1 //number of footprints to be simulated

15.0 15.0 12.5 // center (x,y) and radius of the footprint

//part II stem_map - dimension of the forest stand and a list of all trees:

0.0 0.0 //slope, azimuth in degrees

40.0 40.0 40.0// Maximium dimensions of the stand: MaxX, MaxY, MaxZ

0.0 30.0 0.0 30.0//ranges of x and y (trees within the range are used for 3D scene）

21.45 20.09 15.80 17.40 16.20 3.48 2 0 // This is tree lists. One line for each tree. x； y； dbh(cm)；topH(m); Crown_Length; Crown_radius; species; crown shape code,0 for elipsoid and 1 for cone.

5.4. Optical model

5.4.1 GOMS model

(1)Model introduction

GOMS model is on the foundation of Li-Strahler geometric-optic model, which consider the mutual shadowing of crowns, and makes the geometric optic model more suitable for the high dense canopy forest. Currently, the GOMS model can be applied to simulate the relationship between the canopy structure parameters (height at which a crown center is located (h), horizontal radius of an ellipsoidal crown (R) and sample distribution) and the canopy reflectance characteristics. The model copyright is owning to academician Li Xiaowen; For any questions please contact: Song Jinling songjl@bnu.edu.cn

Reference：

Li, X. and A.H. Strahler, Geometric-optical bidirectional reflectance modeling of the discrete crown vegetation canopy: effect of crown shape and mutual shadowing. Geoscience and Remote Sensing, IEEE Transactions on, 1992. 30(2): p. 276-292.

Xiaowen, L. and A.H. Strahler, Geometric-Optical Bidirectional Reflectance Modeling of a Conifer Forest Canopy. Geoscience and Remote Sensing, IEEE Transactions on, 1986. GE-24(6): p. 906-919.

Xiaowen, L. and A.H. Strahler, Geometric-Optical Modeling of a Conifer Forest Canopy. Geoscience and Remote Sensing, IEEE Transactions on, 1985. GE-23(5): p. 705-721.

（2）Instruction of the GOMS model

The main interface of the model shown in figure 5.4-a, click the “service” button, then the “Run the service” button, and go into the main running interface of the GOMS model, like fugure5.4-b. Figure5.4-b present the sample parameters in the model, shown in figure5.4-c. Press the “clear all” button, then the multi-angle datasets can be cleared out; the “Layers” option can be used to setting the number of the simulation multi-angle datasets, enter the layer number, press the “Add Layers” button , the Layers of the multi-angle datasets can be changed, and then enter the

multi-angle data in the corresponding option to do the model simulation. All of the samples parameters can be changed in the corresponding option.

Press the “Run” button, when the MessageBox shown “System echo －> The service Goms has finished！”, the model computational process has been done. Press the “Results” button, the results will be popped out, shown in figure5.4-d, “outputBRDF.txt” is the result file which contains the simulation BRF along with the view zenith angle .

Press the “outputBRDF.txt” in this interface，the simulation results shown below:

VZA	BRDF
65.00000	0.40544
60.00000	0.38800
55.00000	0.37984
50.00000	0.38066
45.00000	0.39207
40.00000	0.33835
35.00000	0.30164
30.00000	0.27477
25.00000	0.25425
20.00000	0.23832
15.00000	0.22671
10.00000	0.21735
5.00000	0.20882
0.00000	0.20107
-5.00000	0.19403
-10.00000	0.18763
-15.00000	0.18182
-20.00000	0.17650
-25.00000	0.17161
-30.00000	0.16706
-35.00000	0.16277
-40.00000	0.15870
-45.00000	0.15479
-50.00000	0.15104
-55.00000	0.14747
-60.00000	0.14422
-65.00000	0.14163

In this file, **BRF** is the Bidirectional reflectance factor and **VZA** is the view zenith angle. The canopy BRFs are simulated under the given incidence direction, along with the difference of the observation direction(view zenith angle: symbol ’ -’ represents the view position is in the forward observation).

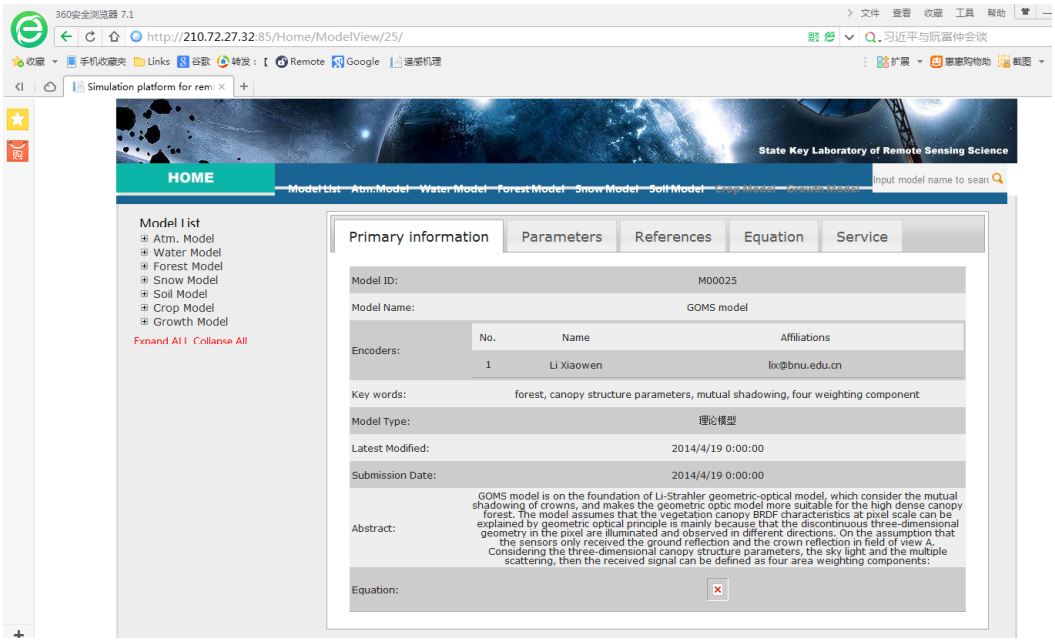

State Key Laboratory of Remote Sensing Science
HOME
Model List
Atm. Model
Water Model
Forest Model
Snow Model
Soil Model
Crop Model
Growth Model
Expand All Collapse All
Primary information
Parameters
References
Equation
Service
Model ID: M00025
Model Name: GOMS model
Encoders:
No. Name Affiliations
1 Li Xiaowen lix@bnu.edu.cn
Key words: forest, canopy structure parameters, mutual shadowing, four weighting component
Model Type: 理论模型
Latest Modified: 2014/4/19 0:00:00
Submission Date: 2014/4/19 0:00:00
Abstract: GOMS model is on the foundation of Li-Strahler geometric-optical model, which consider the mutual shadowing of crowns, and makes the geometric optic model more suitable for the high dense canopy forest. The model assumes that the vegetation canopy BRDF characteristics at pixel scale can be explained by geometric optical principle is mainly because that the discontinuous three-dimensional geometry in the pixel are illuminated and observed in different directions. On the assumption that the sensors only received the ground reflection and the crown reflection in field of view A. Considering the three-dimensional canopy structure parameters, the sky light and the multiple scattering, then the received signal can be defined as four area weighting components:
Equation:

Figure 5.4-a Main interface of GOMS model

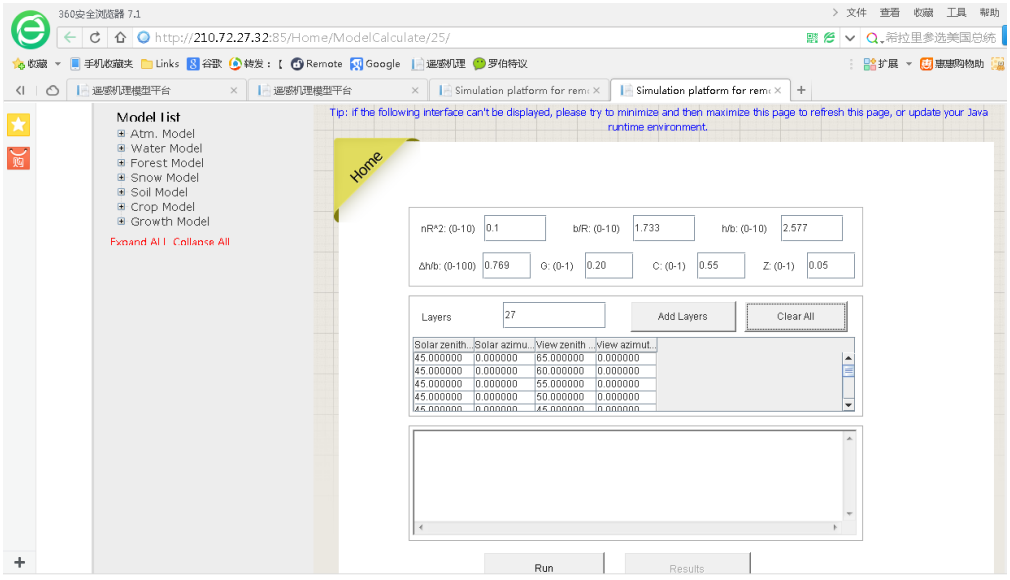


图 5.4-b Main running interface of GOMS model

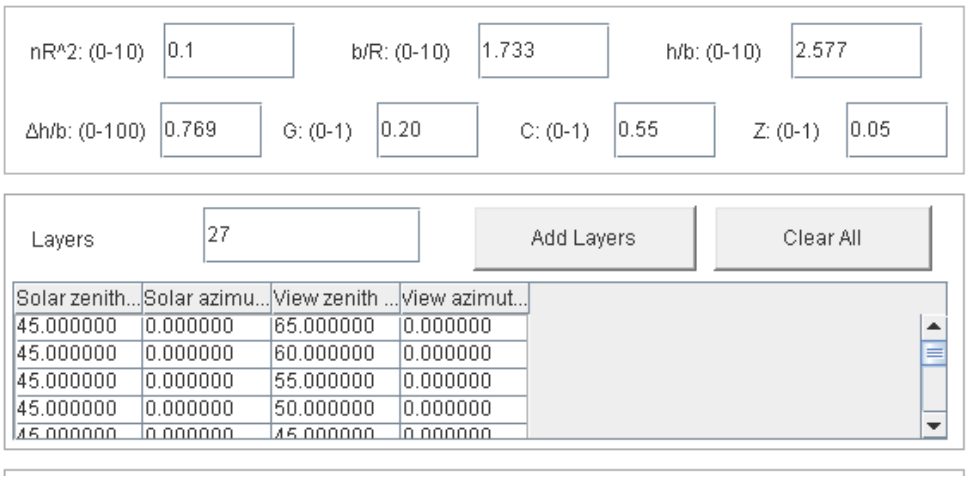


Figure 5.4-c Multi-angle in GOMS model

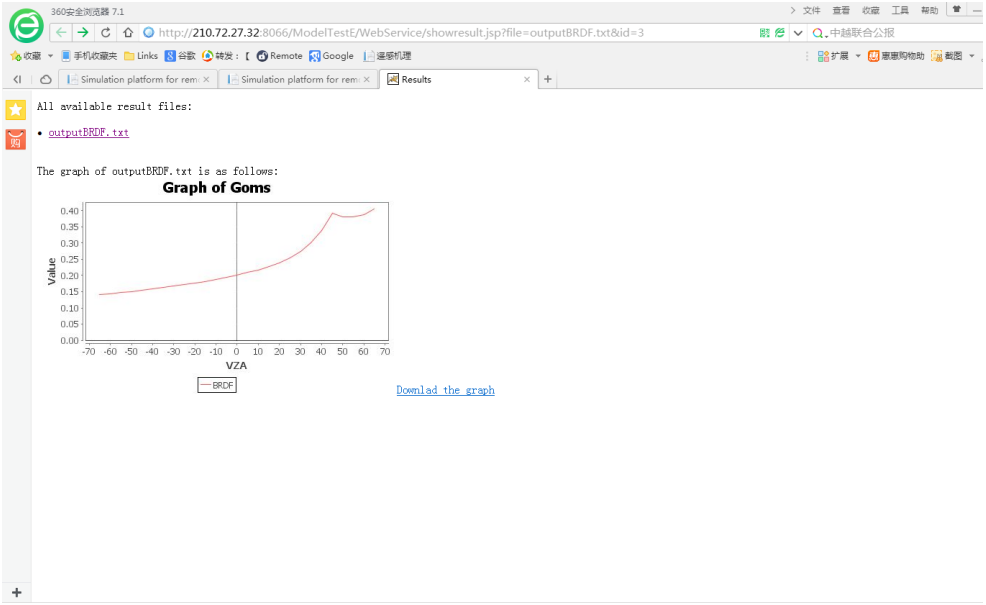


Figure 5.4-d Main interface of the simulation result

（3）parameters in the main running interface of GOMS model

//section1: Forest canopy structural parameters

nR^2: 0.1// nR^2 is the parameter which describes the crown coverage density in the nadir observation; unit: ㎡; value range: depend on the field of view structure(0-10); n: number of crowns per unit area; R: horizontal radius of an ellipsoidal crown

b/R: 1.733//b/R：crown shape parameter; no unit; value range:0-10; b: vertical half axis of an ellipsoidal crown

h/b：2.577//h/b: represents the crown height from the ground; no unit; value range:0-10; h: height at which a crown center is located

Δh/b：0.769//Δh/b: the discrete degree of the crown height distribution; no unit; value range:0-100; Δh: the variance of the h distribution in one pixel

//section2: Spectral component parameters

G：0.2// sunlit background(red/ near-infrared)；no unit; value range:0-1

C：0.55// sunlit crown(red/ near-infrared)；no unit; value range:0-1

Z：0.05// shaded background(red/ near-infrared)；no unit; value range:0-1

//section3: Multi-angle parameters

solar zenith angle: value range 0-90; unit: °; in the main running interface, the data value is 45.

solar azimuth angle: value range 0-360; unit: °; in the main running interface, the data value is zero.

view zenith angle: value range -90-90; unit: °; negative data represents the view position is in the forward observation and positive data is in the backward observation. Generally settings, the view zenith angle is lower than 70

view azimuth angle: value range 0-360; unit: °; relative azimuth angle(relative azimuth angle= Abs(view azimuth angle-solar azimuth angle)), if relative azimuth angle is lower than 90, the view position is in the backward observation, and if relative azimuth angle is higher than 90, the view position is in the forward observation.

6. Crop

6.1 Passive microwave model

6.1.1 First-order Model

(1) Introduction

The first-order model simulates the passive microwave signals in terms of the energy equilibrium. Compared to the zeroth-order model, i.e. ω-τ model, it consider the first-order volume scattering in the vegetation. So the model can be applied to denser vegetation.

When modeling the radiative transfer process for vegetation covered ground, the vegetation layer is assumed as a mixture of dielectric scatters with different sizes, shapes, and certain orientations and distributions. The total emission signal of the vegetation layer is considered to be the sum of signals contributed by each scatter.

Without considering the effects of the atmosphere and the vegetation fraction, the first-order model can be written as follows,

$$Tb1 = D + AG + SG + V$$

where Tb1 is the total radiation of the vegetation covered ground, D is the upward, self-emitted brightness temperature of the vegetation, AG is the direct soil emission attenuated by the vegetation, SG is the downward, self-emitted emission of the vegetation that is respectively reflected and attenuated by ground surface and vegetation layer, V is signal of volume scattering within the vegetation.

The first-order model can simulate the vegetation covered ground quite well, especially suited for the short vegetation covers areas.

Any questions please contact: Linna Chai chai@bnu.edu.cn

Reference

1. Microwave Scattering and Emission Models and their Applications, A.K.Fung, Artech House, 1994.

2. Electromagnetic wave scattering from some vegetation samples . M.A. Karam, A.K. Fung,

et.al., IEEE TGARS, Vol.26, No.6,pp.799-808,1988

3. Scattering from arbitrarily oriented dielectric disks in the physical optics regime, ,D.M. LeVine, Meneghini, H. Lang, S.Seker, Journal of Optical Society of America, vol.73, 1255-1262, 1983.

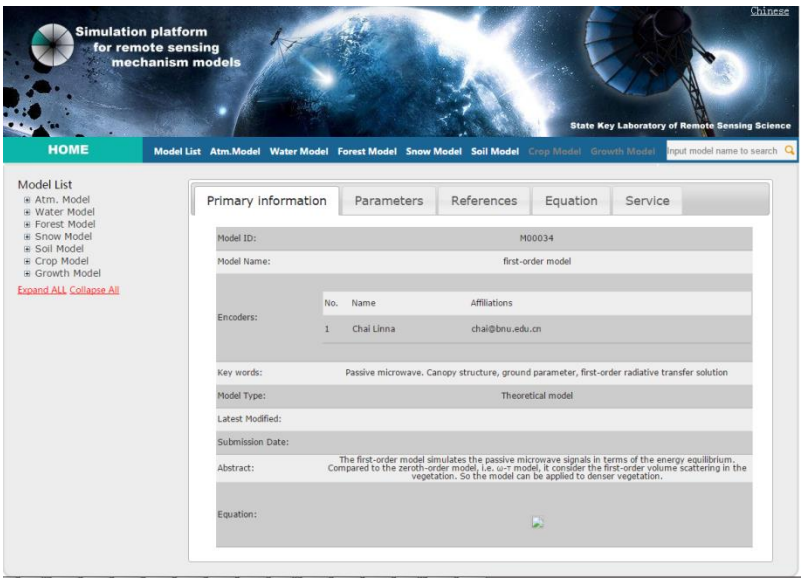
4. Electromagnetic scattering from a layer of finite-length, randomly oriented dielectric circular cylinders over a rough interface with application to vegetation", Karam, M. A. and A. K. Fung, Int. J. of Remote Sensing,Vol.9, No.6, 1109–1134, 1988

5. Emission of Rough Surfaces Calculated by the Integral Equation Method With Comparison to Three-Dimensional Moment Method Simulations, Chen.K.S, Wu.T.D, Tsang L,IEEE Trans Geosci Remote Sensing, 2003, 35:731-749'

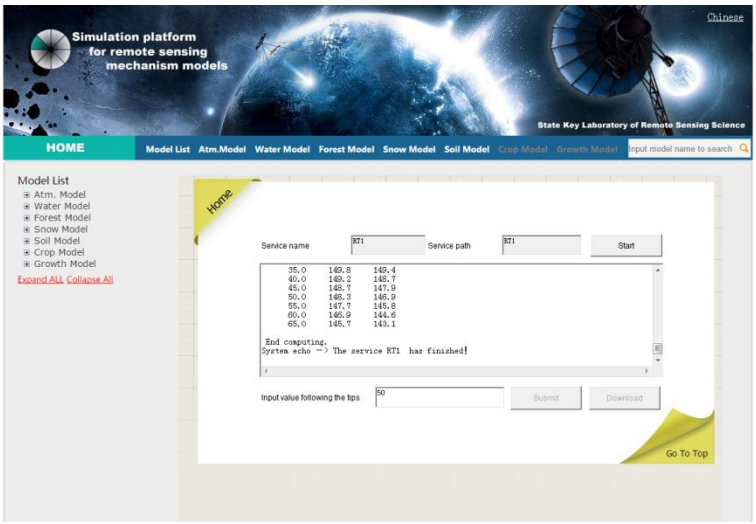
(2) Instruction

The model home page is shown as fig. 6.1.1-a. Click “Service”->“Run the service” button, then you enter the model running interface, as shown in fig. 6.1.1-b.Click “start” button, the model will be running. You can input the parameters according to the tips shown on the interface. After each input, you should click “submit” to do the next, like fig. 6.1.1-c.

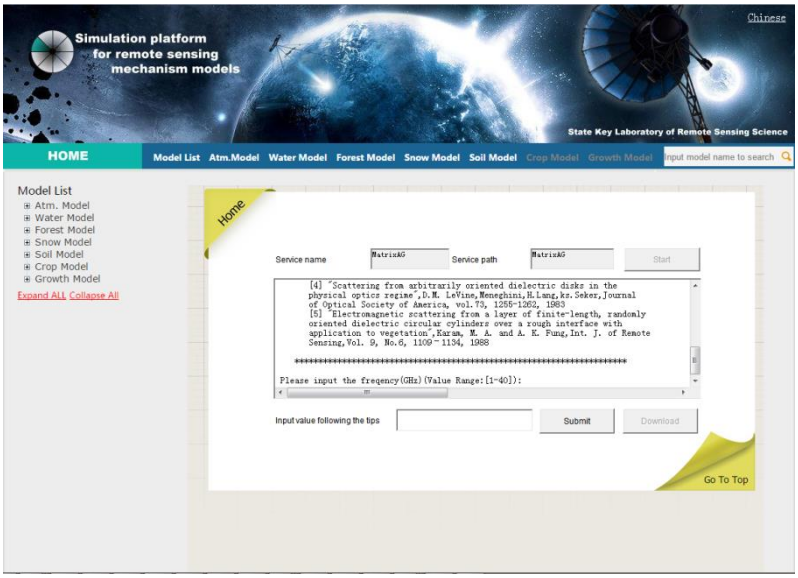
As the model ends running, the dialog box will show “system echo->the service RT1 has finished”, as shown in fig. 6.1.1-d. And the button “submit” is disabled. You can check the result in the page, e.g. the brightness temperature of H and V polarization from 5 °to 65 °.



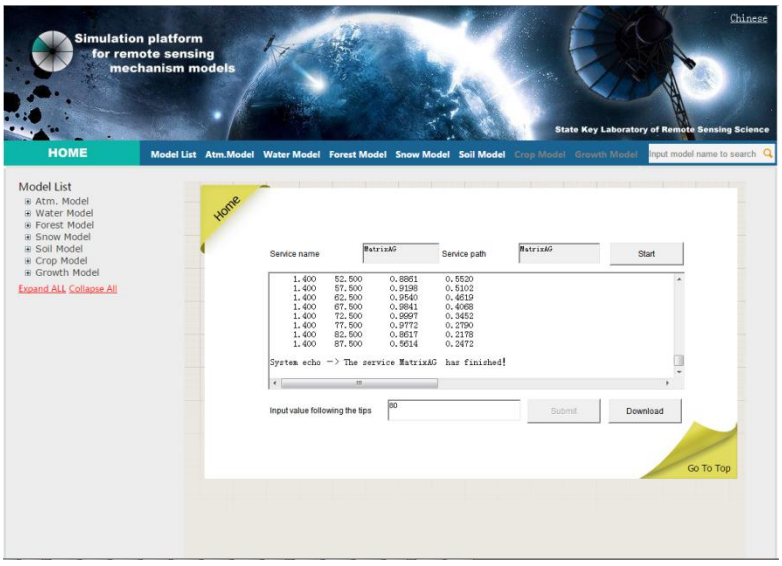
6.1.1-a Model home page



6.1.2-b Model running interface



6.1.1-c Parameter input interface



6.1.1-d Result interface

(3) Instruction of model

Please input the freqency(GHz):6.925 % simulated emitted frequency
Please input the soil parameters:
soil temperature(℃):30 % Ground temperature
volume moisture(%):30 % soil moisture
standard deviation(m):0.02 % Soil roughness standard deviation
surface correlation length(m):0.1 % Soil roughness average slope

Please input the vegetation parameters:
canopy depth(m):0.19 % Canopy depth, excluding stalk
vegetation temperature(℃):26.3 % Average temperature within the vegetation
leaf radius(m):0.0267 % Statistically average radius of round leaf
leaf thickness(m):0.00023 % Statistically average thickness of round leaf
leaf number(m-3):316 % Statistically average leaf number per unit
leaf moisture(%):82.2 % Statistically average leaf moisture

branch radius(m):0.0009 % Statistically average branch cross-section radius
branch height(m):0.05 % Statistically average branch height
branch number(m-3):285 % Statistically average branch number per unit
branch moisture(%):88.1 % Statistically averagebranch moisture

6.2 Active microwave model

6.2.1 First-order microwave crop scattering model

Introduction

First-order microwave crop scattering model was coded based on MIMICS model, which was developed by Prof. F. T. Ulaby. Based on phase matrix of crop scatterers and first-order radiative transfer model, radar backscattering coefficients from crop canopy are estimated. The copyright of MIMICS model belongs to Prof. F. T. Ulaby. If any problem related to the web-based application, please contact: Dr. Du Jinyang，dujy@radi.ac.cn

Reference

Ulaby, Fawwaz T., Richard K. Moore, and Adrian K. Fung. "Microwave Remote Sensing Active and Passive-Volume II: Radar Remote Sensing and Surface Scattering and Emission Theory." (1982).

Ulaby, Fawwaz T., et al. "Michigan microwave canopy scattering model."International Journal of Remote Sensing 11.7 (1990): 1223-1253.

Usage

Graphic user interface (GUI) of this model is shown in Fig. 6.2.1, firstly click “Service” tab, then click “Run the service”. GUI of the model running is shown in Fig. 6.2.2. Click the “Run” button to start calculation.

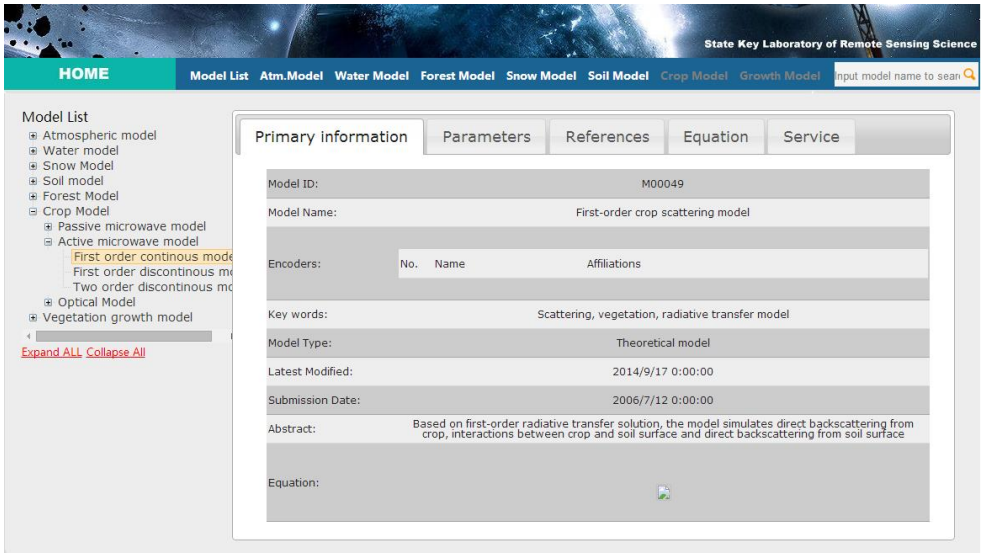


Fig.6.2.1 Main Interface

Model inputs are based on human-computer interactions. The input parameters are put by users based on the valid range defined by the program and indicated on the input interface. Specific input parameters include： (1) Frequency, valid range [1.26,10.7] GHz； (2) Incidence angle，valid range [30.0,60.0] degree； (3) volumetric ratio of vegetation scatterers, valid range [0.0001,0.01]；(4) water content of vegetation scatterers, valid range [0.30, 0.90]; (5) crop height，valid range [0.1, 5] m; (6) Volumetric soil moisture [0.05,0.4] m^3/m^3. Based on the inputs, VV, HH, VH and HV polarized backscattering coefficients are calculated by the model. An example of the application is shown below：

Input parameters：frequency, 5.4 GHz； incidence angle，40 degree；volumetric fraction of vegetation scatterers: 0.004；water content of vegetation scatterers: 0.6; crop height: 2.0 m; Volumetric soil moisture 0.25 m^3/m^3

Output：VV －11.73 dB， HH－11.75 dB, VH －15.89 dB, HV －15.89 dB

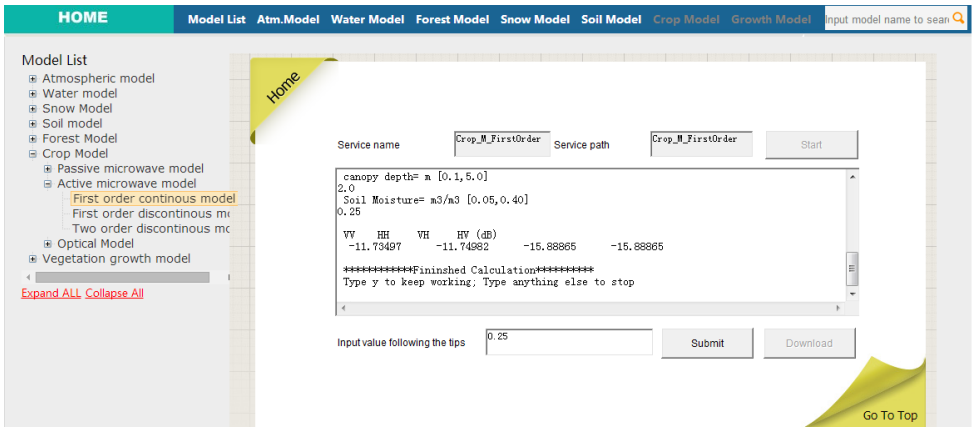


Fig.6.2.2 Operation Interface

6.2.2 Second-order microwave crop scattering model

Introduction

Second-order microwave crop scattering model was coded based on MIMICS model, which was developed by Prof. F. T. Ulaby. Based on phase matrix of crop scatterers and second-order radiative transfer model, radar backscattering coefficients from crop canopy are estimated. The copyright of MIMICS model belongs to Prof. F. T. Ulaby. If any problem related to the web-based application, please contact: Dr. Du Jinyang，dujy@radi.ac.cn

Reference

Ulaby, Fawwaz T., Richard K. Moore, and Adrian K. Fung. "Microwave Remote Sensing Active and Passive-Volume II: Radar Remote Sensing and Surface Scattering and Emission Theory." (1982).

Ulaby, Fawwaz T., et al. "Michigan microwave canopy scattering model."International Journal of Remote Sensing 11.7 (1990): 1223-1253.

Usage

Graphic user interface (GUI) of this model is shown in Fig. 6.2.3, firstly click “Service” tab, then click “Run the service”. GUI of the model running is shown in Fig. 6.2.4. Click the “Run” button to start calculation.

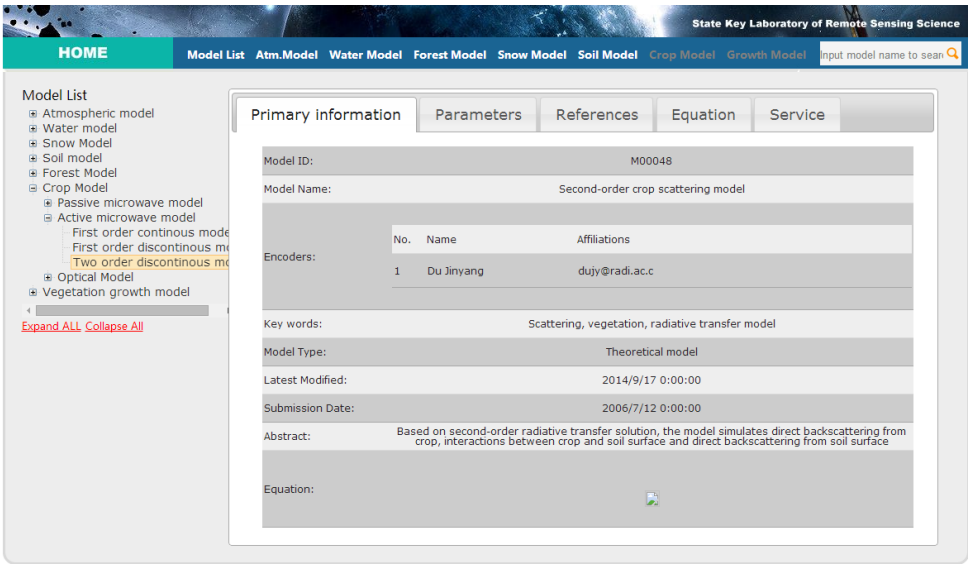


Fig.6.2.3 Main Interface

Model inputs are based on human-computer interactions. The input parameters are put by users based on the valid range defined by the program and indicated on the input interface. Specific input parameters include： (1) Frequency, valid range [1.26,10.7] GHz； (2) Incidence angle，valid range [30.0,60.0] degree； (3) volumetric ratio of vegetation scatterers, valid range [0.0001,0.01]；(4) water content of vegetation scatterers, valid range [0.30, 0.90]; (5) crop height，valid range [0.1, 5] m; (6) volumetric soil moisture [0.05,0.4] m^3/m^3. Based on the inputs, VV, HH, VH and HV polarized backscattering coefficients are calculated by the model. An example of the application is shown below：

Input parameters：

Frequency: 5.4 GHz； Incidence angle:40 degree； Volumetric fraction of vegetation

scatterers:0.004；Water content of vegetation scatterers: 0.6; Crop height: 2.0 m; Volumetric soil moisture: 0.25 m^3/m^3

Output：VV －9.86 dB， HH－9.87 dB, VH －14.22 dB, HV －14.22 dB

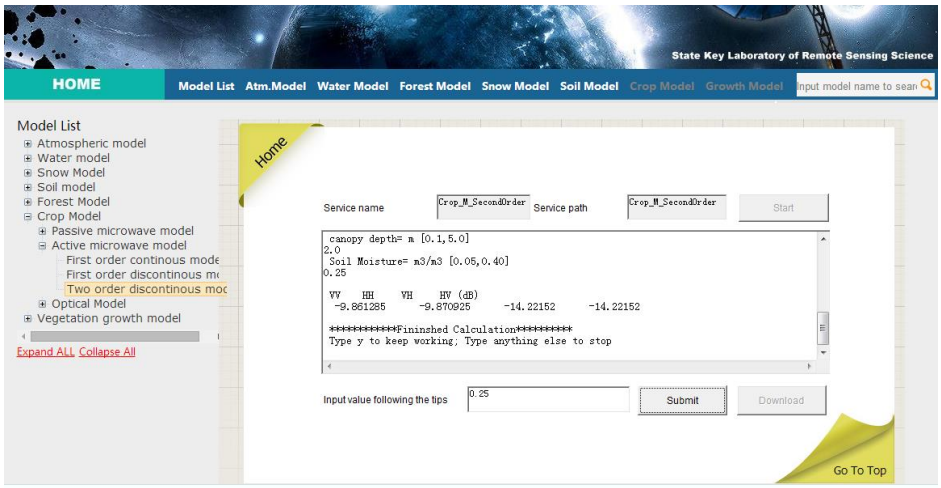


Fig.6.2.4 Operation Interface

6.3 Optical model

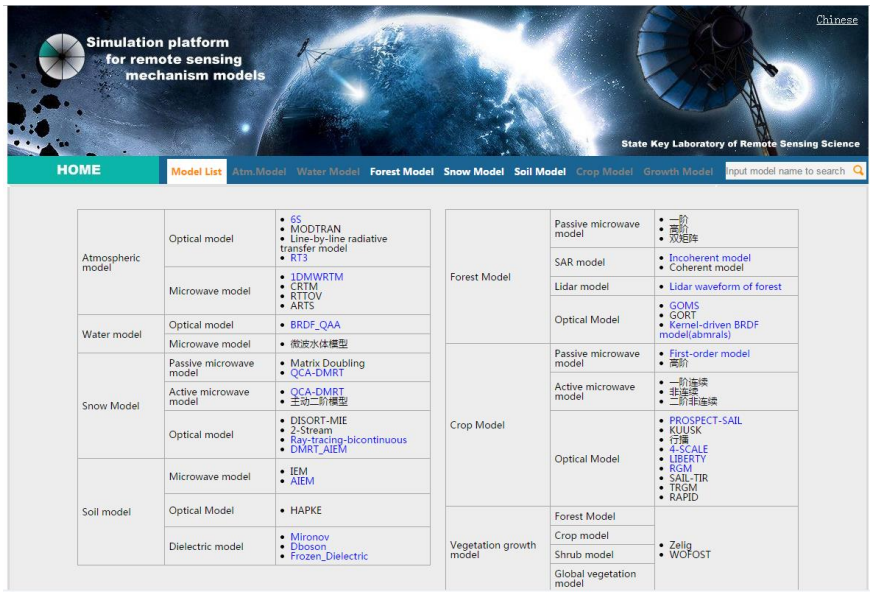
6.3.1 PROSPECT-SAIL model

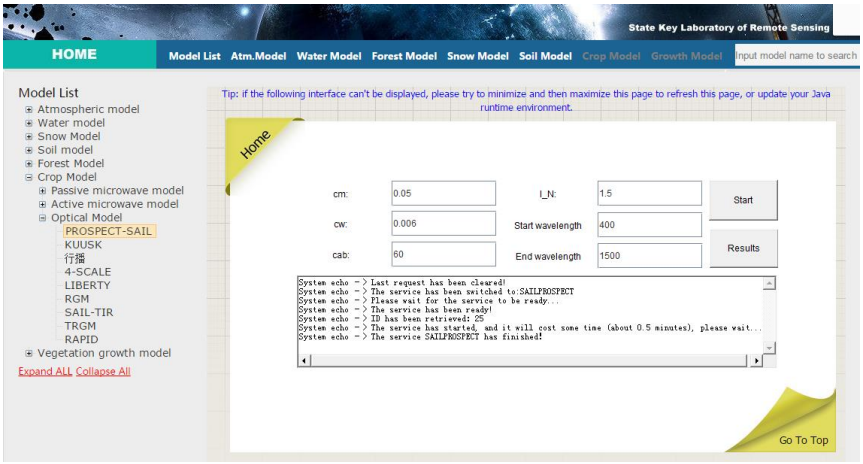
（1）Model introduction

SAIL model is a one-dimensional radiative transfer model of canopy scale widely used. It can simulate the bidirectional reflectance of crop canopy for arbitrary leaf angle. The PROSPECT model is the leaf scale widely used model. It can simulate leaf reflectivity and transmittance in the wavelength range of 400-2500 nm.

(2) Description of model usage

Click the "Model List" to enter the page of model list and select “Crop model”->”Optical Model”->”PROSPECT-SAIL”. Click the hyperlink “PROSPECT-SAIL” enter the operation interface. Click the tab of "Service", and click the button of "Run the service" to enter the main interface of PROSPECT-SAIL model. Input parameters are listed. User can modify these inputs. Click the button of "Run" to carry out the model. The operating state will display in the text box during model running process. After finished the program, a text box will display that "system echo! -> The services PROESPECT-SAIL has finished". After that, click the button of "Results" to display the model simulation results.

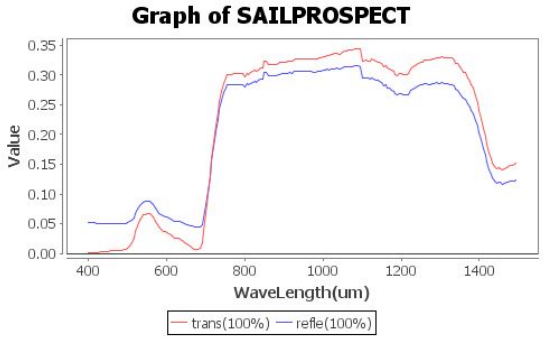




All available result files:

- Prospect_Outupt.txt

The graph of Prospect_Outupt.txt is as follows:



Downlad the graph

6.3.2 LIBERTY conifer leaf model

(1) Model introduction

The conifer leaf model LIBERTY (Leaf Incorporating Biochemistry Exhibiting Reflectance and Transmittance Yields) is an adaptation of radiative transfer theory for determining the optical properties in the visible and near-infrared bands from 400-2500nm spectral for conifer leaves.

LIBERTY provides a simulation, at a fine spectral resolution, of quasi infinite leaf reflectance (as represented by stacked leaves) and single leaf reflectance. Single leaf reflectance and transmittance are important input variables to vegetation canopy reflectance models. In the model, the blade or needle consider as a collection of cells. The multiple scattering among the cells were also considered. The output spectrum is a function between three main chemical structure parameters (the average diameter of the cells, the leaf thickness and the gap sizes among cells) and absorption coefficient of the leaf chemical elements (chlorophyll, water, cellulose, lignin and protein). Professor Dawson hold all copyright of the model. Any questions please contact: terry.dawson@ecu.ox.ac.uk.

Reference：

Dawson, T. P., P. J. Curran and S. E. Plummer, LIBERTY Modeling the Effects of Leaf Biochemical Concentration on Reflectance Spectra. Remote Sensing of Environment, 1998. 65(1): p.50-60.

(2) Description of model usage

Click the tab of "Service", and click the button of "Run the service" to enter the main interface of LIBERTY model. The main interface of LIBERTY model is shown in Figure 6. 3.2-a. Click the button of "Run" to carry out the LIBERTY model. The operating state will display in the text box during model running process, which is shown in Figure 6. 3.2-b. After finished the program, a text box will display that "system echo! -> The services Liberty has finished". After that, click the button of "Results" to display the model simulation results, as shown in Figure 6.3.2-c.

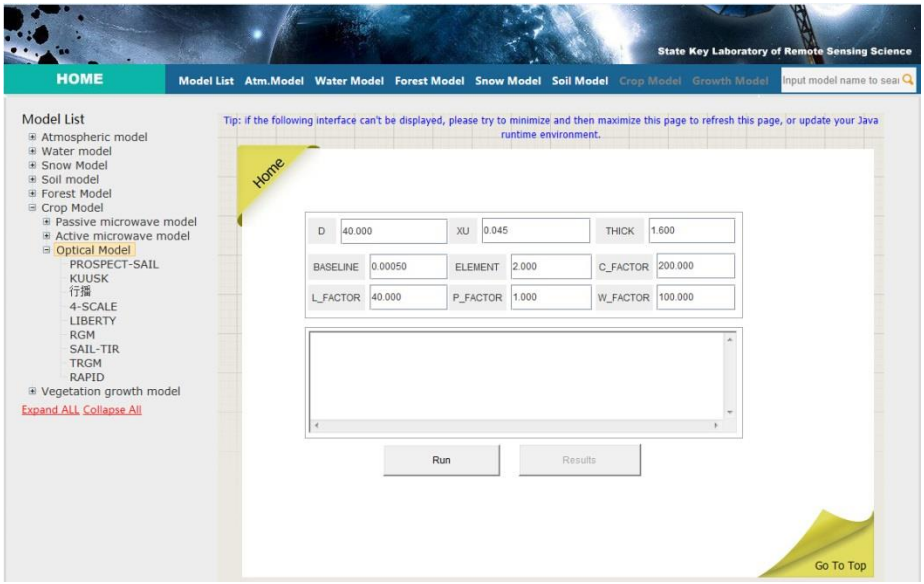


Figure 6. 3.2-a The main interface of LIBERTY model.

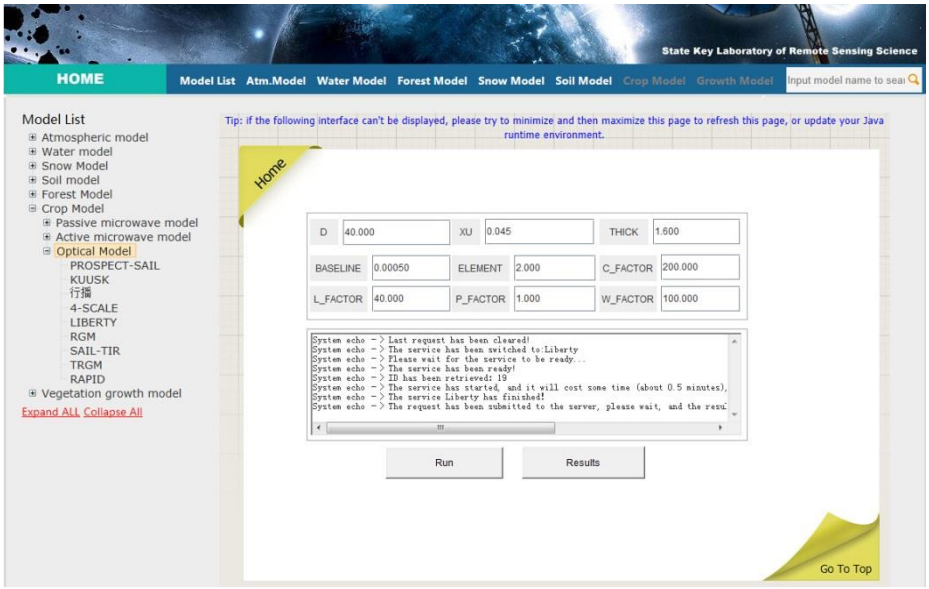


Figure 6.3.2-b The finished interface of LIBERTY model.

(3) Description of parameters in the input file sample.txt

// Input and output file settings.
OUTPUT_FILE output.txt // Output file.
OPTICAL_FILE optical_oa.txt // Input file.
LIBERTY_DEFAULT 1 // Whether to simulate with the default parameters.

// Input files for absorption coefficient.
PIGMENT_FILE pigment.txt // Files for pigment absorption coefficient.
WATER_FILE water.txt // Files for water absorption coefficient.
ALBINO_FILE albino.txt // Files for albino absorption coefficient.
LIGCELL_FILE ligcell.txt // Files for lignin and cellulose absorption coefficient.
PROTEIN_FILE protein.txt // Files for protein absorption coefficient.

// Input parameter values.
m_D 40.000 // Average diameter of the cells.
m_XU 0.045 // Gap sizes among cells.
m_THICK 1.600 // Leaf thickness.
m_BASELINE 0.00050 // Base absorption coefficient.
m_ELEMENT 2.000 // Element baseline.
m_C_FACTOR 200.000 // Chlorophyll content.
m_L_FACTOR 40.000 // Lignin and cellulose content.
m_P_FACTOR 1.000 // Protein content.
m_W_FACTOR 100.000 // Water content.

6.3.3 Four-scale model

(1) Model introduction

The Four-scale geometric-optical bidirectional reflectance model considers four scales of

canopy architecture: tree groups, tree crowns, branches and shoots. It differs from the Li-Strahler's model in the following respects: 1) the assumption of random spatial distribution of trees is replaced by the Neyman distribution which is able to model the patchiness or clumpiness of a forest stand; 2) the multiple mutual shadowing effect between tree crowns is considered using a negative binomial and the Neyman distribution theory; 3) the effect of the sunlit background is modeled using a canopy gap size distribution function that affects the magnitude and width of the hotspot; 4) the branch architecture affecting the directional reflectance is simulated using a simple angular radiation penetration function; and 5) the tree crown surface is treated as a complex surface with micro-scale structures which themselves generate mutual shadows and a hotspot. Professor Chen J.M. hold all copyright of the model. Any questions please contact: chen@ccrs.nrcan.gc.ca.

Reference：

Chen, J.M. and S.G. Leblanc, Chen JM, A Four-Scale Bidirectional Reflectance Model Based on Canopy Architecture. IEEE Transactions on Geoscience and Remote Sensing, 1997. 35(5): p. 1316-1337.

(2) Description of model usage

Click the tab of "Service", and click the button of "Run the service" to enter the main interface of Four-scale model. The main interface of Four-scale model is shown in Figure 6.3.3-a. Click the button of "Run" to carry out the Four-scale model. The operating state will display in the text box during model running process, which is shown in Figure 6.3.3-b. After finished the program, a text box will display that "system echo! -> The services Four-scale has finished". After that, click the button of "Results" to display the model simulation results, as shown in Figure 6. 3.3-c.

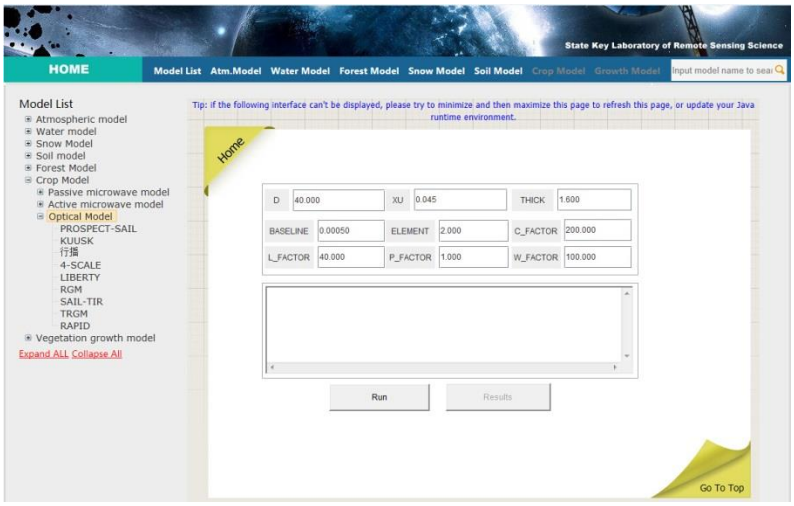


Figure 6. 3.3-a The main interface of Four-scale model.

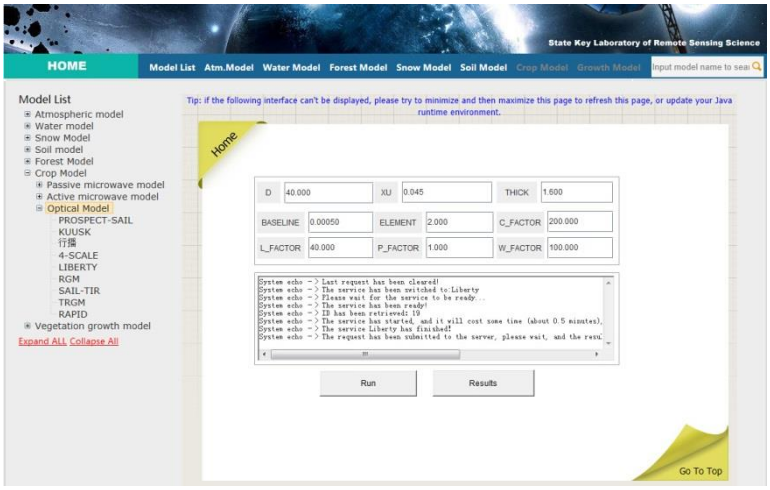


Figure 6. 3.3-b The finished interface of Four-scale model.

(3) Description of parameters in the input file sample.txt

// The input and output file settings
ANGLE_FILE angle.txt // the input angle file
OUTPUT_FILE out.txt // the output file
OPTICAL_FILE optical_oa.txt // the input optical reflectance file

// The mode selection
SPECTRAL 1 // the selection of spectrum mode
LIBERTY_DEFAULT 1 // whether to call LIBERTY model
GE_CHOICE NO_BRANCH // whether there is branching crown
SHAPE SPHEROID // the shape of crown: spheroid or cone+cylinder

// Input parameters
Ha 10.0 // Height of the lower part of the tree (trunk space).
Hb 7.0 // Height of cylinders.
A 0.00 // Branch structure parameter determines the functional of G, A is related with angle θ.
C 0.50 // Branch parameters determine the functional of G, C is a constant.
LAI 2.40 // Leaf area index (LAI).
B 10000.0 // Domain size (pixel size).
D 1000 // Number of trees in the domain B.
n 40 // Number of quadrats in the domain B.
R 1.30 // Radius of the tree crowns.
m2 2 // Cluster mean size.
SZA 45.0 // Solar zenith angle (SZA).
BAND 670.0 865.0 1600.00 1600.0 // Band wavelength range.
// The reflectance and transmittance correspond to the four spectral bands.
G1 0.050
GZ1 0.001
G2 0.270

GZ2 0.010
G3 0.200
GZ3 0.005
G4 0.200
GZ4 0.005
T1 0.070
TZ1 0.001
T2 0.470
TZ2 0.010
T3 0.100
TZ3 0.005
T4 0.100
TZ4 0.005
TT1 0.020
TT2 0.300
TT3 0.150
TT4 0.150
Ws 0.05 // Mean width of element shadows cast inside tree crowns.
OMEGA 0.98000 // Clumping index for trees.
GAMMA_E 1.410 // Clumping index for shoots.
ALPHA_B 10.0 // Branches angle.
ALPHA_L 20.0 // Shoots angle.
Ll 0.800 // Sub foliage area index.
Fr 0.00 // Overlapping area.
ALPHA 13.0 // Half apex angle.
RATIO 0.20 // Leaf thickness and width ratio.
Rb 0.1 // Branch thickness.
DeltaLAI 0.20 // Increase in leaf area index.

6.3.4 TRGM model

7. Vegetation growth model

7.1 Crop

7.2 Shrub

7.3 Forest